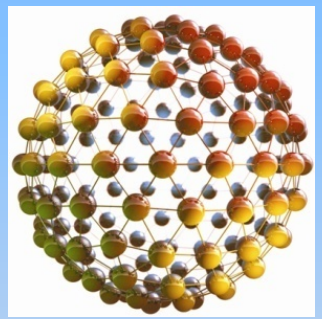
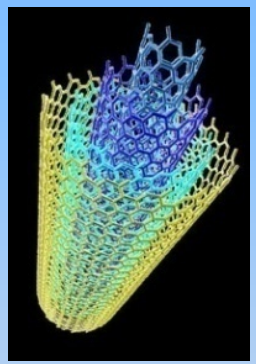
Managing Chemical & Material Risks

Acquisition, Technology and Logistics





November 2013

Paul Yaroschak, P.E.
Deputy for Chemical & Material Risk Management
Office of the Deputy Under Secretary of Defense
(Installations & Environment)

Chemical Related Programs in Our Portfolio

- **Emerging Contaminants Program**
- **DoD-wide chemical management policy**
  - **Enterprise chemical data management**
  - **REACH[1] Strategic Plan**
- **Review & comment of IRIS risk assessments**
- **DoD Strategic Sustainability Performance Plan**
  - **Required by E.O. 13514…requires reduction in toxic substances**
- **Sustainable Chemicals & Materials for Defense Forum**
- **ESOH policy & procedures for DoD acquisition process**
  - **Chemical safety & hazard communication are important elements**
  - **Sustainability Analysis Initiative using Life Cycle Assessment**

[1] Registration, Evaluation, Authorisation and Restriction of Chemicals

Part 1 – Context, Trends, & Emerging Contaminants (ECs) Program Refresher

Trends

- **Use of Precautionary Principle**
  - Must understand health & environmental effects before using chemicals
- **Bio-monitoring – What's showing up in humans?**
  - Centers for Disease Control's national bio-monitoring & California voluntary program
- **Evolving Risk Assessment Science & Process**
- **Green Chemistry**
- **International, Federal, & State Chemical Management Laws & Regulations**
  - Restrictions or banning of chemicals/materials (e.g., BPA)
  - EPA Chemical Management Plans
  - California Green Chemistry Law
  - EU's REACH
  - Pending TSCA[1] reform

[1] Toxic Substances Control Act

Emerging Contaminants Program History

- **~2004 – Perchlorate detections in groundwater & drinking water**
  - Disputes between DoD and regulators over response actions
- **2005 – DoD forms EC Work group with EPA & ECOS**
  - EC Definition agreed
- **2006 – Three white papers developed**
  - Tiered toxicity values - What if no IRIS value?
  - Action Triggers – When to take action when no IRIS value
  - Risk Communication – What to tell the public
- **2008/9 – DoD creates EC funding line & policy instruction**
- **2009 – Harvard University "Innovations in American Government" Award**

What is an Emerging Contaminant?

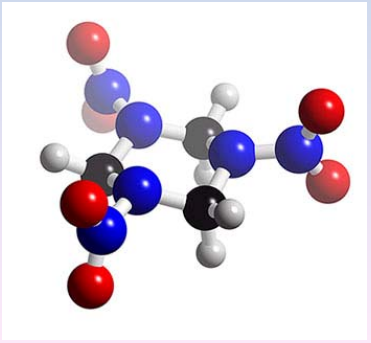
- Chemicals & materials that have pathways to enter the environment and present real or potential unacceptable human health or environmental risks…

and either

  - do not have peer-reviewed human health standards

or

  - Standards/regulations are evolving due to new science, detection capabilities, or pathways.



EC "Scan-Watch-Action" Process

Over -the- horizon

EC News

Review literature, periodicals, regulatory communications, etc.

Possible DoD impacts

Phase I Assessment

Monitor events; Conduct Phase I qualitative impact assessment

Probable high DoD impacts

Phase II Assessment

Conduct Phase II quantitative impact assessment; develop & rank RMOs*

→ **Risk Management Options (RMOs) to ECGC**

↓

Approved RMOs become Risk Management Actions (RMAs)

Program Scorecard – Cumulative

- **Potential ECs screened --- over 600**
- **Phase I Impact Assessments completed --- 32**
- **Phase II Impact Assessments completed --- 11**
  - All current/former action list chemicals completed.
- **60 Risk Management Options (RMOs) developed & turned into Risk Management Actions (RMAs)**
  - **32 completed, 20 in-progress, 5 pending, 3 deferred**

EC Watch List – November 2013

- ✓ Tungsten/alloys
- ✓ 1,4-dioxane*
- ✓ Metal Nanomaterials
- ✓ Carbon Nanomaterials
- ✓ Perfluorooctyl sulfonate (PFOS)
- ✓ Perfluorooctanoic acid (PFOA)
- ✓ Di-nitrotoluenes (DNT)
- ✓ Nickel
- ✓ Cadmium
- ✓ Manganese

- Cobalt
- Antimony
- ✓ Diisocyanates
- ✓ Dioxins
- ✓ TCE ...moved from action list
- ✓ Perchlorate ...moved from action list
- ✓ decaBDE
- ✓ Vanadium & compounds
- NDMA
- DNAN
- NTO

] *Energetic Compounds*

✓ Phase I Impact Assessment completed

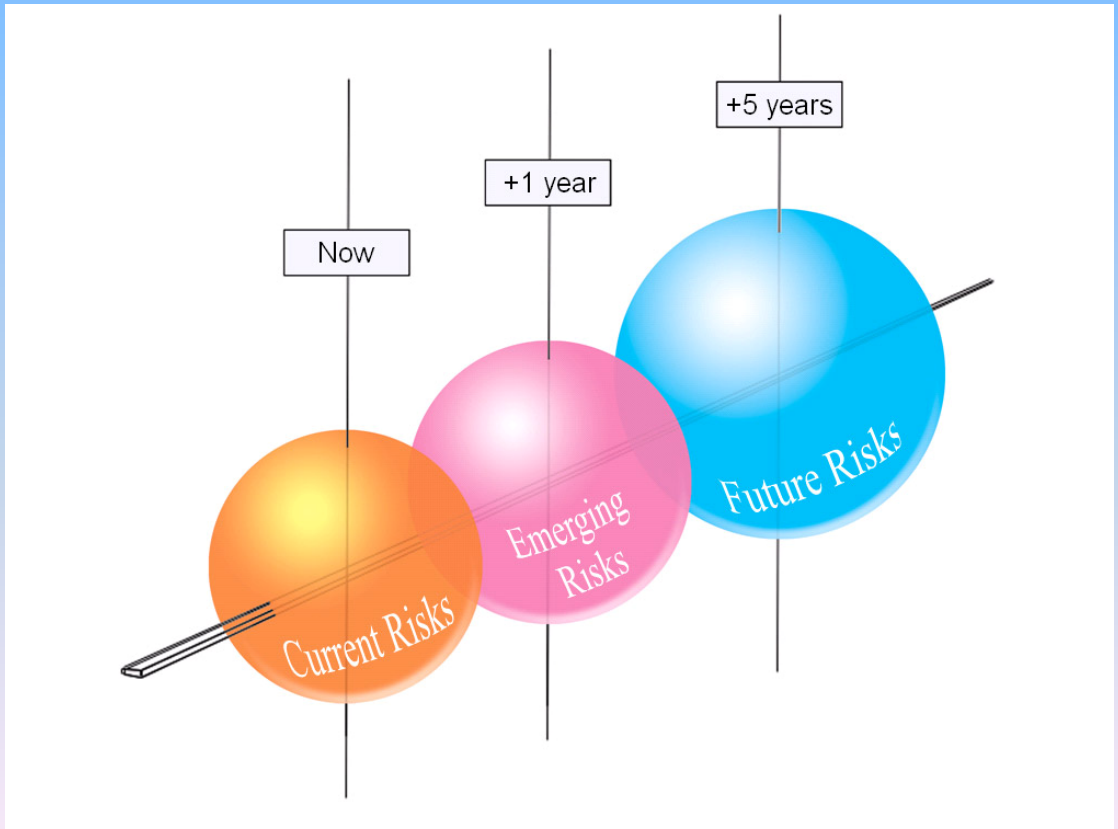
* To be re-assessed

EC Action List – November 2013

- ✓ **Royal Demolition eXplosive (RDX)**
  - Cyclotrimethylenetrinitramine
- ✓ **Hexavalent Chromium (Cr6+)**
- ✓ **Naphthalene** **…pending downgrade to watch list**
- ✓ **Beryllium (Be)**
- ✓ **Sulfur Hexafluoride (SF6)**
- ✓ **Lead**
- ✓ **Phthalates**
- **1-Bromopropane** **…pending ECGC approval**

✓ **Phase II Impact Assessment completed.**

Part 2 – Risks & Risk Management Actions



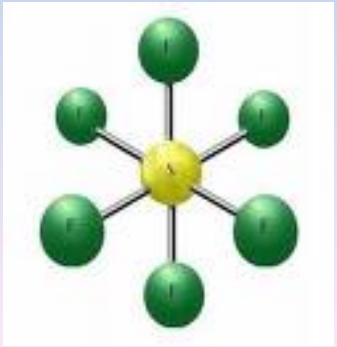
Perchlorate Risk Management Strategy

- **DoD Policies & Sampling/Characterization – Find the releases**
  - DoD Sampling began ~15 years ago
  - DoD 2006 sampling policy memo required sampling in all media (ranges covered by DoDI)
  - California site prioritization protocol completed
  - DoD 2009 policy uses new EPA recommended Preliminary Remediation Goal (PRG); supersedes previous policy memos and says use EPA RfD
- **Response via DERP[1] – Address the releases**
  - Lack of MCL *does not stop* response actions
  - RfD used for site-specific risk assessments
- **Invest in R&D – Determine sources & substitutes**
  - Over $114M invested in perchlorate substitutes
  - Sampling & analytical methods, and
  - Treatment technologies

[1] Defense Environmental Restoration Program

Sulfur Hexafluoride (SF6) Background

- A non-flammable, non-toxic gas – no human health concerns
- Extremely stable, with excellent dielectric properties (electrical insulation and arc-quenching)
- A high global warming potential – 22,800 times more potent than carbon dioxide (CO_2) – long lasting in the atmosphere
- Average global SF6 concentration has increased by about 7 percent per year during the 1980s and 1990s

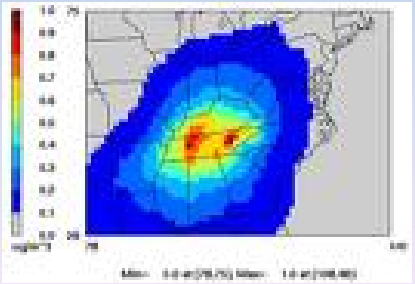


SF6 Commercial Uses

- High-voltage electrical switchgear & transformers
- High-energy imaging equipment
- Research - atomic particle tandem accelerators

SF6 Military Uses

- Pressurization/dielectric for aircraft targeting pods/avionics -- Airborne Warning and Control System (AWACS) radar (e.g., E-3 Aircraft)
- Waveguide pressurization for shipboard targeting radar (e.g., MK 92 Fire Control System)
- Comprehensive Nuclear Test Ban Treaty monitoring and nuclear event detection



SF6 Phase I Impact Assessment

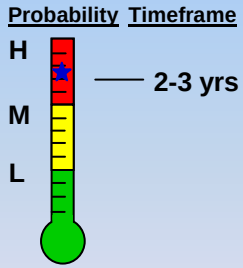
Completed January 2008

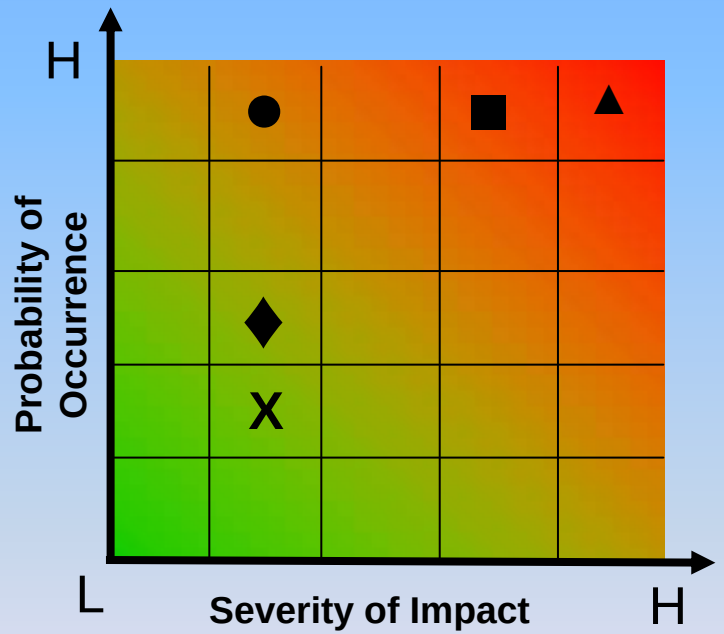
Acquisition, Technology and Logistics

Sulfur Hexafluoride (SF6) is used in radar systems (e.g., AWACS aircraft); helicopter rotor-blade leak tests; discharge testing in fire suppression systems; electrical switch gear; and propulsion systems for specific weapons (e.g., MK-50 torpedo) in service and under design.

Likelihood of Toxicity Value/ Regulatory Change

1. **Probability that Greenhouse Gas emission initiatives will restrict use/availability of SF6**



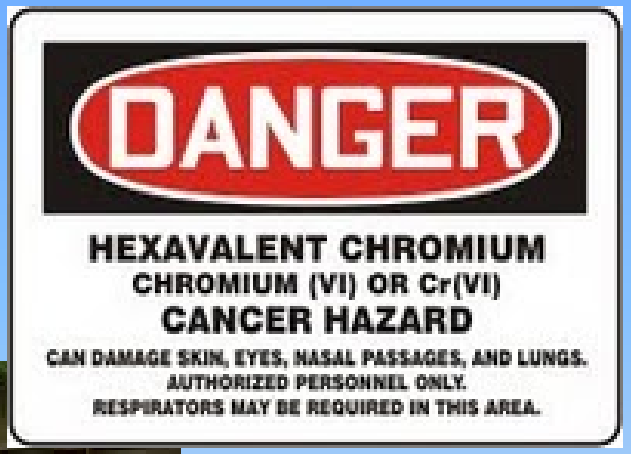


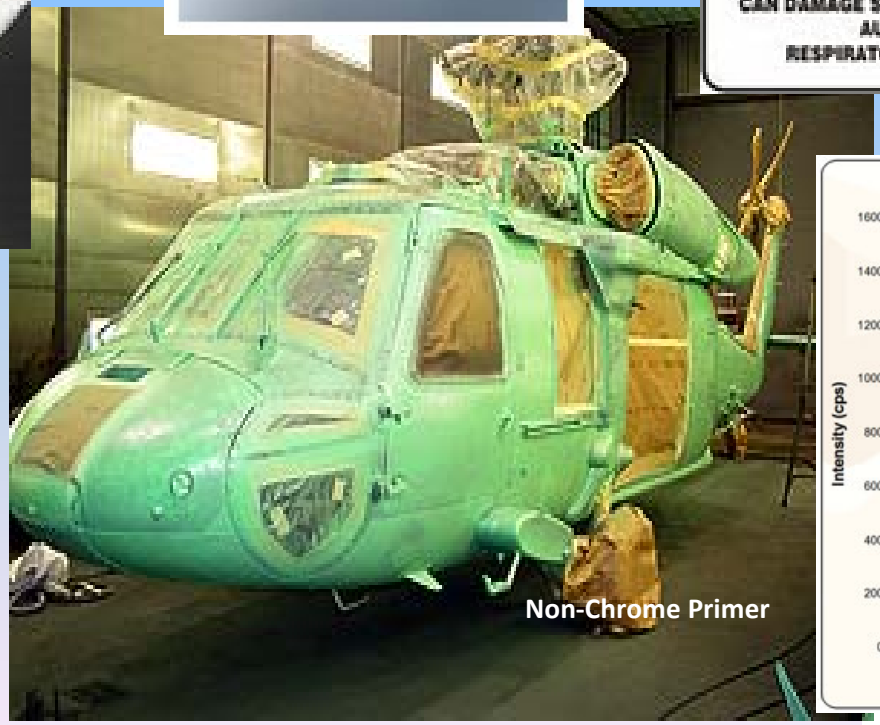
- ♦ ES&H
- ■ Training & Readiness
- ▲ Acquisition/RDT&E
- ● PO&MD of Assets
- X Cleanup

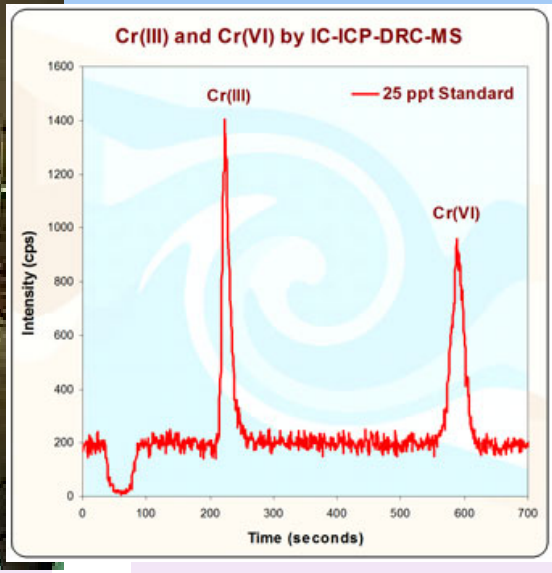
SF6 Risk Management Actions

- **DoD Policy issued on SF6 capture & recycling**
- **RDT&E on substitutes for mission critical applications**
- **Coordination with Electric Power Research Institute on substitutes for electrical infrastructure**

DoD Hexavalent Chromium Minimization

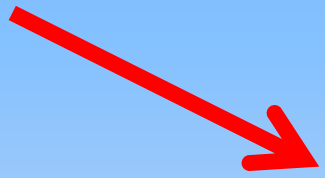






Desired DoD Paradigm Shift for Cr6+

- Default use of Cr6+
- “Promotion” of substitutes
- Can result in business as usual

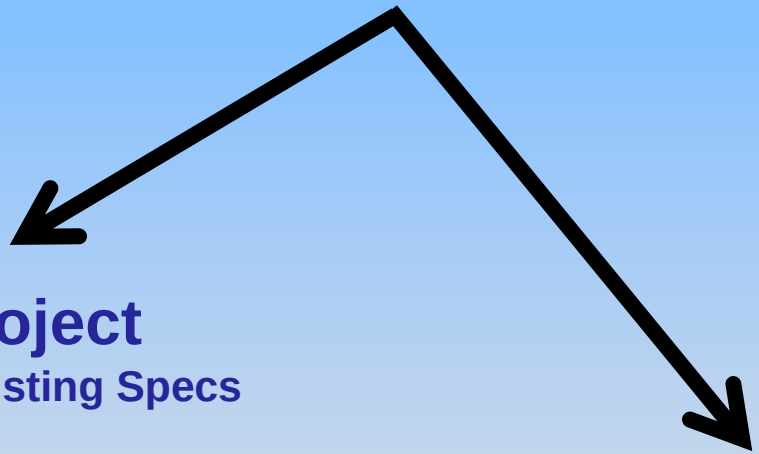


- Default use of substitutes
- Use of Cr6+ if no substitute can meet performance requirements
- Bias for change

Note: The required performance shouldn’t be based on Cr6+ but on a level of acceptable performance for the application

Three Part Cr6+ Strategy

Cr6+ Minimization Policy
USD(AT&L) memo of 8 April 2009
Sets the Desired Course



Legacy Project
Minimize Cr6+ in Existing Specs

Defense Federal Acquisition Rule
Minimizes Cr6+ in New Acquisitions

Lead – Why on the Action List?

- **Evolving science & regulations pose a risk to range operations…most munitions contain lead**

- **Lead-free electronics pose a risk to DoD supply chain…short-circuiting in components**

Lead Risk Management Actions

- **RDT&E on lead free munitions**
- **DoD-Industry Consortium on lead-free electronics**
  - **Develop technologies to detect lead-free circuit boards**
  - **Develop viable lead-free solders**
- **National Academy of Sciences Study**
  - **Concern: Lead exposures to personnel such as small-arms range instructors given new human health science**
  - **Conclusion:** "A review of the epidemiologic and toxicologic data allowed the committee to conclude that there is overwhelming evidence that the OSHA standard provides inadequate protection for DOD firing-range personnel and for any other worker populations covered by the general industry standard."

- **Underway: Development of DoD BLL standards**
  - **Surveillance & action levels**

Department of Defense Emerging Contaminants Program

Harvard University – Ash Institute for Democratic Governance & Innovation

Integrating Sustainability into DoD Acquisition Programs

October 2013

Paul Yaroschak, P.E.
Deputy for Chemical & Material Risk Management
Office of the Deputy Under Secretary of Defense
(Installations & Environment)

Objectives

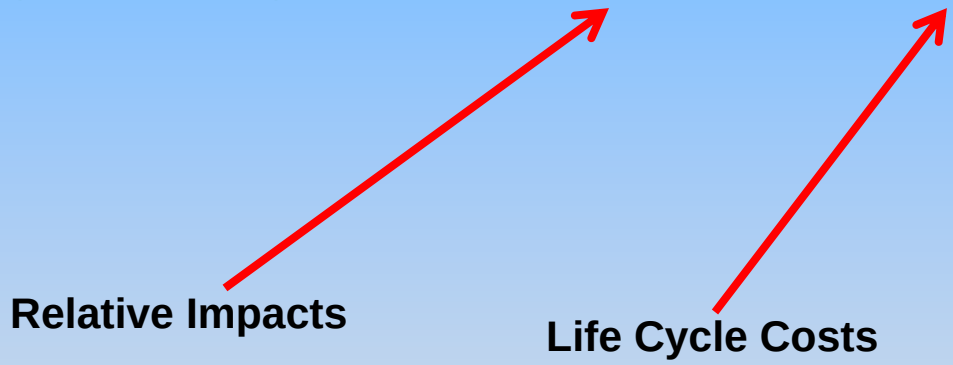
Better Informed Acquisition Decisions leading to:

- **Increased sustainability of systems, platforms and supporting infrastructure**
- **Lower Total Ownership Cost**

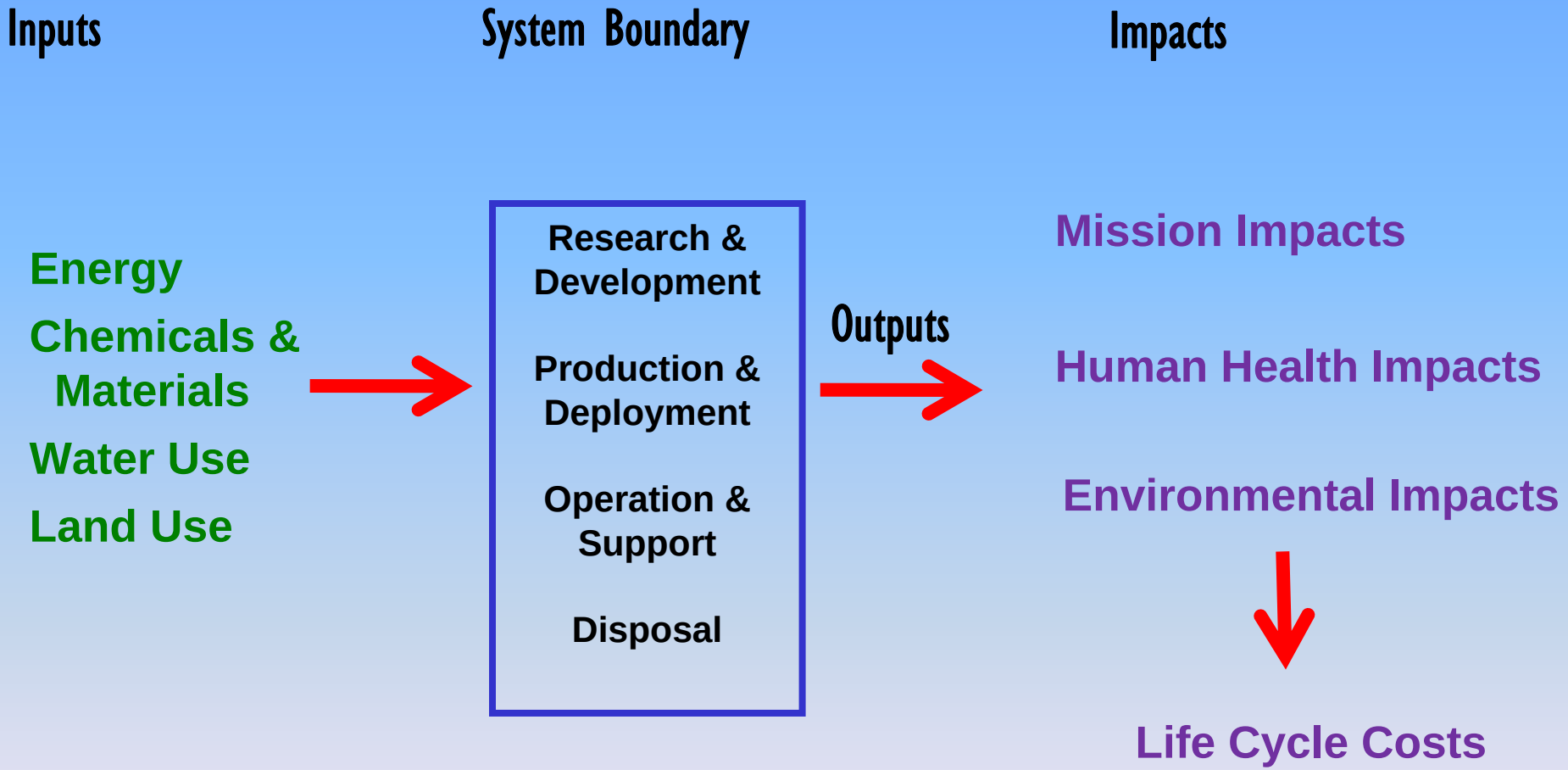
How? Sustainability Analysis Using Life Cycle Assessment (LCA) Methods

Sustainability Analysis

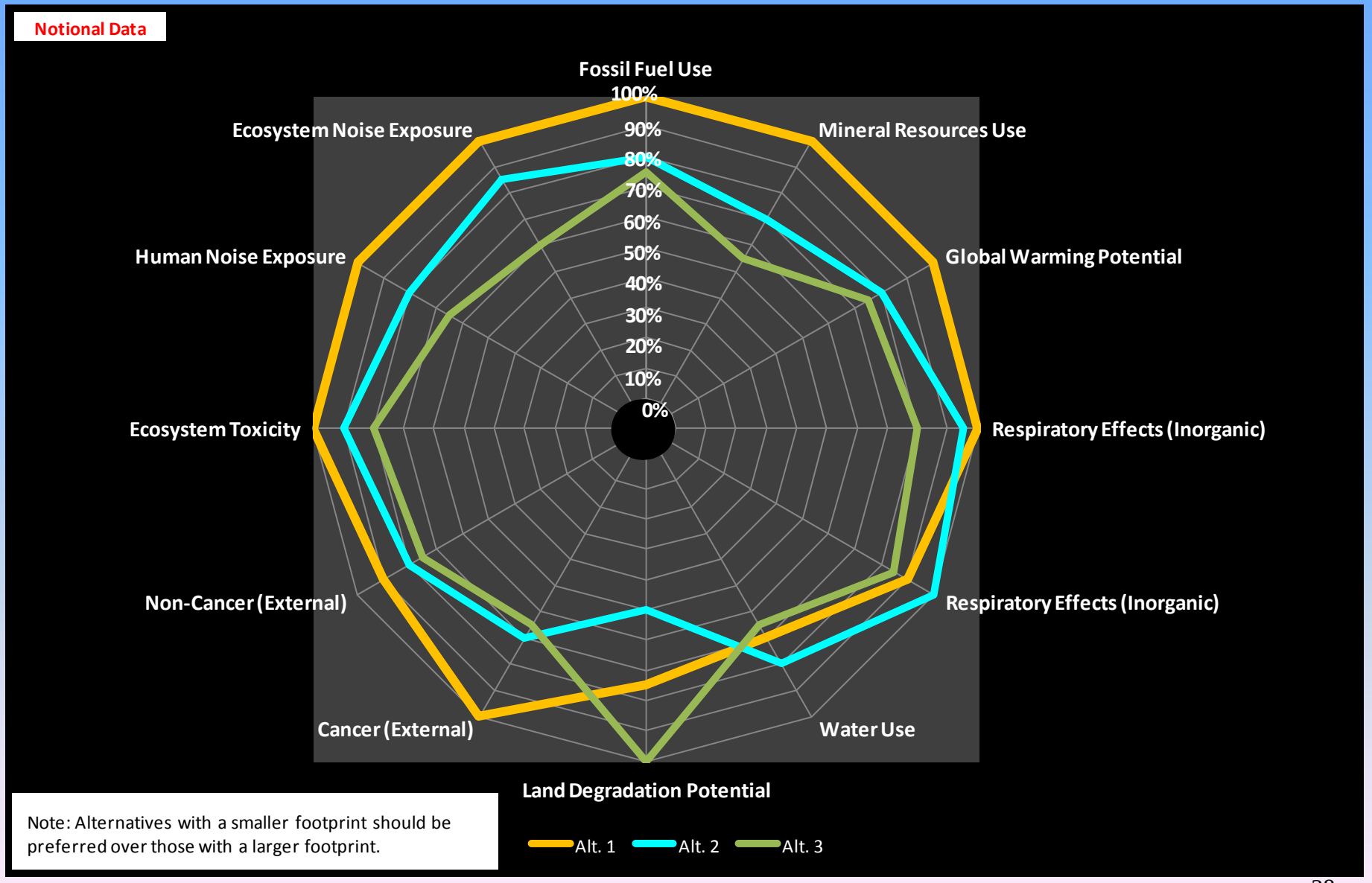
Sustainability Analysis = SLCA + LCCs



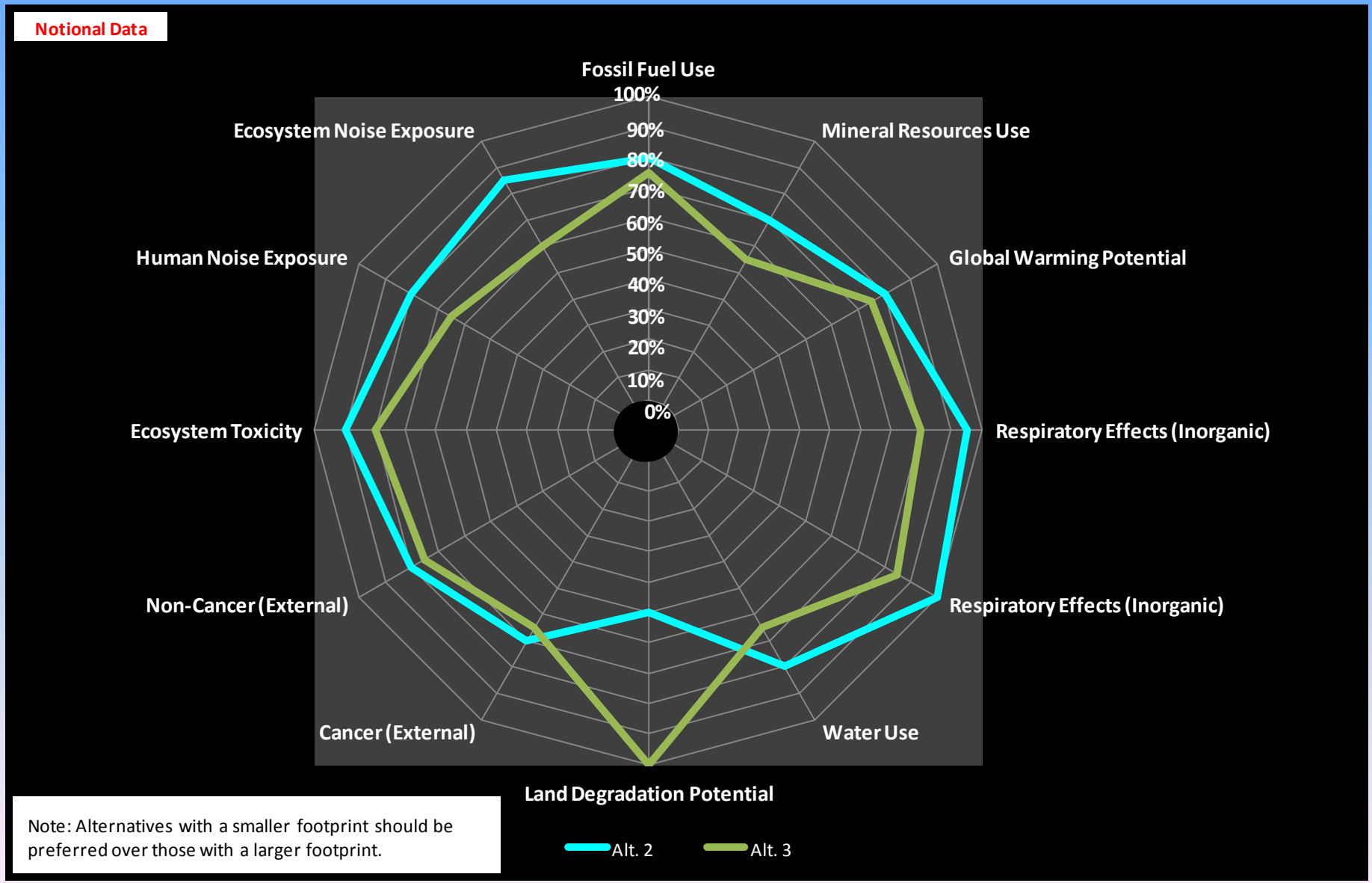
SLCA Model for DoD



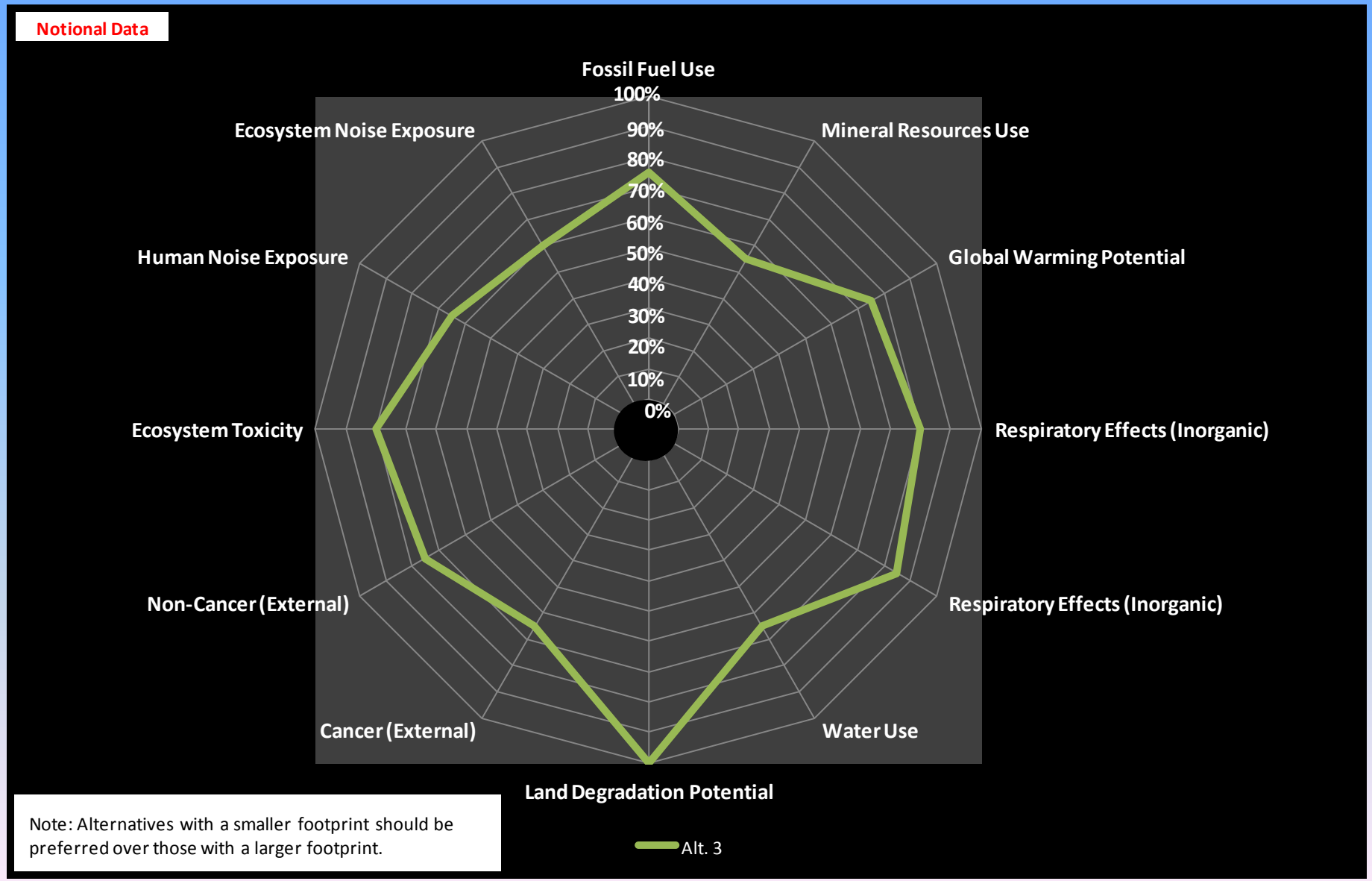
Spider-web Diagram



Spider-web Diagram



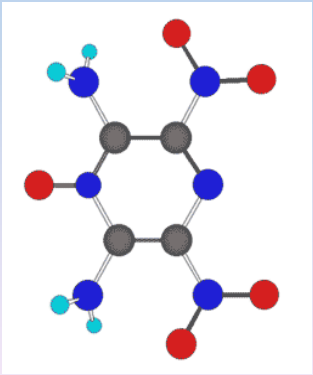
Spider-web Diagram



Note: Alternatives with a smaller footprint should be preferred over those with a larger footprint.

Questions & Discussion

Paul Yaroschak, P.E.
Deputy for Chemical & Material Risk Management
Office of the Deputy Under Secretary of Defense
(Installations & Environment)
1225 S. Clark St., Suite 1500
Arlington, VA 22202
703-604-0641
paul.yaroschak@osd.mil

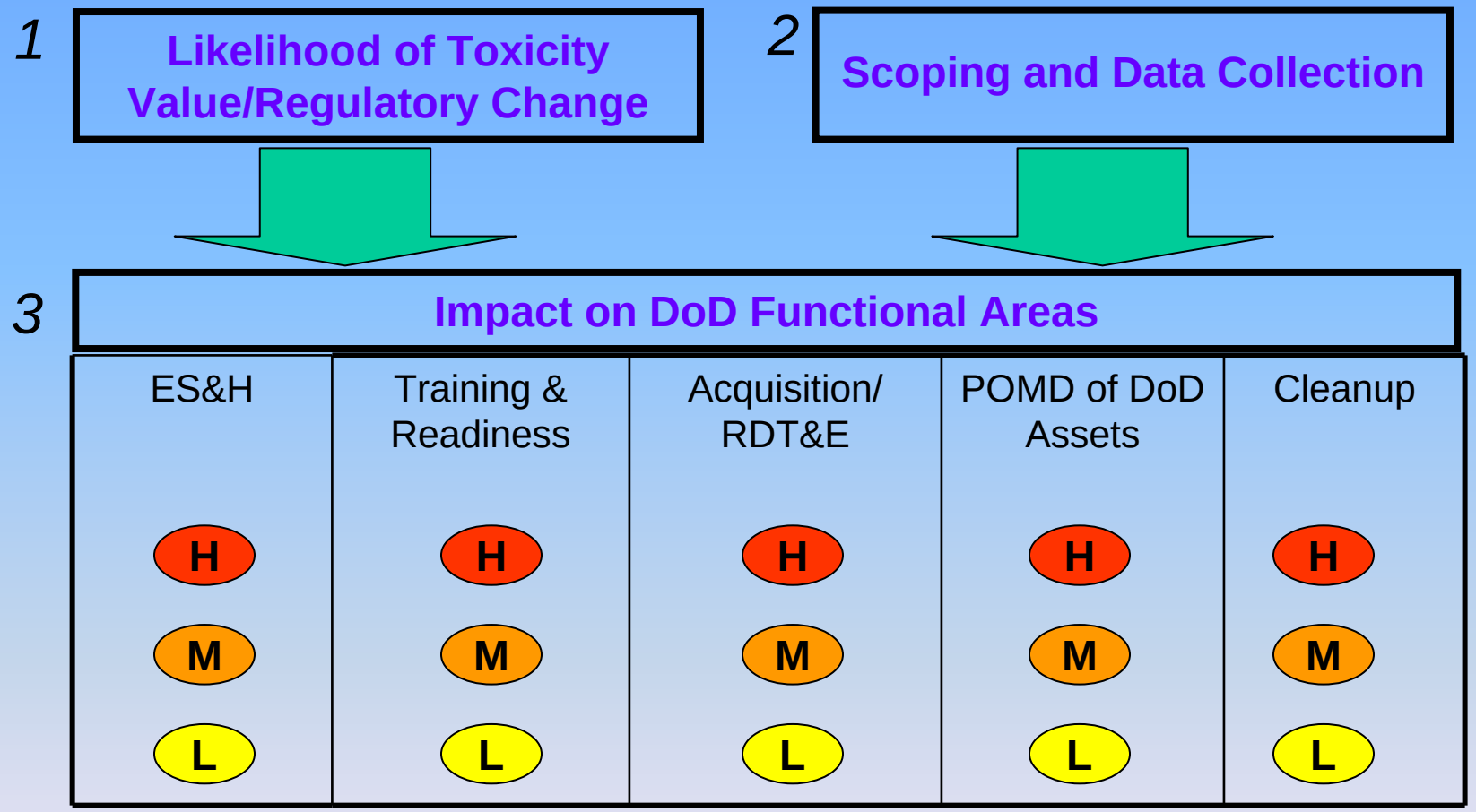


Backup Slides

How Can ECs Affect DoD?

- **Cause adverse health effects on operating forces, DoD employees, and/or public**
  - Human health protection paramount
- **Reduce training/readiness**
  - Restrictions on use of ranges
- **Restrict availability and/or cost of materials or chemicals**
  - Adverse impact on mission-critical applications & industrial base community
- **Increase O&M and/or cleanup costs**
  - Resource drain from mission needs

Phase I Impact Assessment Process

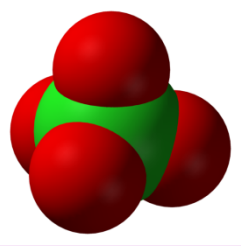


Results:

- **Recommendation – Move to Action List?**
- **Initial Risk Management Options**

Perchlorate - Background

- A salt…1 chlorine + 4 oxygen atoms …Highly soluble in water…can inhibit normal thyroid function at certain levels…pregnant women/fetuses especially sensitive
- Potassium or ammonium perchlorate is used as an oxidizer in **s**ome missiles, rockets, munitions due to its powerful and insensitive nature (DoD/NASA)
- Also used in fireworks, explosives, road flares, matches, dyes, paint, air bags, recyclable batteries
- Found in some fertilizers, degradation of household bleach products, water disinfection products, herbicides and other products with chlorine or perchloric acid
- Found naturally – in arid parts of the world



Evolving Perchlorate Science

- **2005 NAS[1] Peer Review of science**
  - Recommended RfD of 0.0007 mg/kg/day
- **2006 CDC[2] studies (more ongoing)**
- **2007 FDA[3] "Market Basket" Total Diet Study**
  - Various foods (e.g., lettuce, tomatoes, milk) tested for perchlorate
  - Perchlorate intake from food is below the current RfD for even sensitive subpopulations
- **State/Federal/Academic Studies**
  - Numerous sources, including natural, likely contributors to exposure
  - Isotopic analysis now allows distinguishing between natural and man-made sources…more details later in brief
- **EPA IG Report – Dec 2008**
- **EPA Request for More Information for Regulatory Determination Analysis – Aug 2009**
- **Research continued to date**
  - Much focused on impacts of perchlorate relative to other goitrogens

[1] NAS = National Academy of Sciences 2 CDC = Center for Disease Control 3 Food & Drug Administration

DoD-Wide Perchlorate Sampling Results

- **Over 300 installations/FUDS sampled to date**
  - Represents all potential sources of releases in all media
  - Over 52,000 samples …vast majority below 4 ppb
    - Installation summaries on line for public access; Annually updated
- **All sites with possible perchlorate releases have appropriate actions* underway or completed in consultation with regulators**

* Actions underway include any or all of: initial sampling, continuous monitoring, risk assessments, consultation with regulators, & remedial actions

California Prioritization Protocol Results
- A Success Story-

- **DoD & CAL agreed on protocol to screen DoD sites for risk to ground/surface drinking water**
- **Total of 924 possible sites jointly screened**
  - Details on next slide
- **DoD & CAL met in March 2008 to review results**
  - CAL-DTSC and WQCB agree that no sites currently pose a threat to drinking water
  - Appropriate actions being taken regarding releases - Mostly confined to DoD properties
- **DoD and CAL authored article in *Environmental Management* journal describing success of program**

What Are the Potential Sources of Perchlorate?

- **Road Flares**
  - 20-40 million flares sold annually; 5-6% potassium perchlorate in unburned flares
  - Max concentration leaving highway 314,000 ppb (measured)

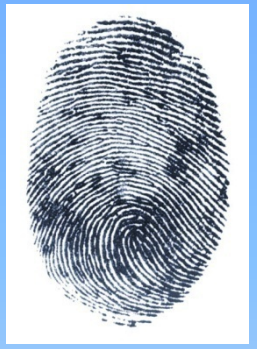
- **Fireworks**
  - Over **200 M lbs**. consumed in U.S. per year…90% imported
  - Fireworks contain up to 70% potassium perchlorate
  - Field sampling…Pre-fireworks at non-detect…Post fireworks up to 5000 ppb
- **Fertilizers**
  - >100 million lbs. Chilean fertilizer applied in the U.S.; High in perchlorate…100,000 ppb
  - > 400,000 lbs. per year still being applied (e.g., organic farming)

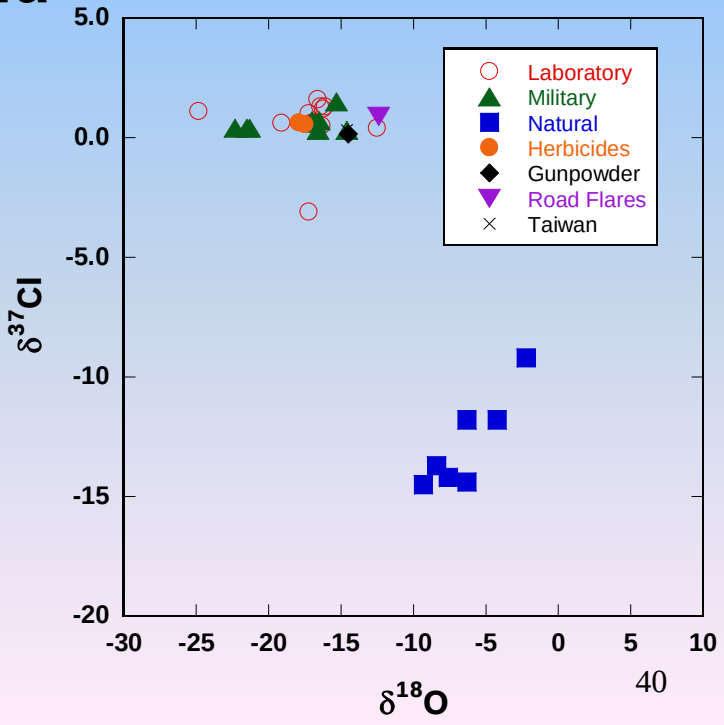
- **Defoilants/Weed Killers**
  - By product - 17,000-22,000 ppb
- **Household Bleach & Drinking Water Treatments**
  - Increases with age and with exposure to sunlight
- **Natural Sources**
  - Arid southwest US & Antarctica*
- **Ozone**
  - Uptake by plants theorized as a mechanism by which perchlorate is found in plants; initi studies O_3 nonattainment areas have plants with higher perchlorate

* Environmental Science & Technology, February 15, 2010

Techniques now Available to Distinquish Natural from Manmade Sources: Isotopic Analysis

- **Elements in a compound can have widely different isotopic ratios or atomic mass based on mode of formation**
- **Stable isotope ratios provide a unique "fingerprint" of a chemical compound**
- **Future research shows promise for distinguishing among different manufactured sources**





DoD Perchlorate Substitution RDT&E

- **Replacement of Perchlorate in Training Simulators**
  - Ground Burst Simulators & Hand Grenade Simulators
    - Account for majority of expended perchlorate on Army Training ranges
    - Production contract for replacement composition (black powder) was awarded in February 08; Limited production began in 09, Full manufacturing production in 11
  - Booby Trap Simulators: Production of 3 types of perchlorate-free versions - phase in FY11-13
  - Training Rocket Warhead (2.75” Rocket): perhaps as early as FY13 - production pending final qualification and Program Manager approval

- **Perchlorate-Free - Pyrotechnic Signal Smokes and Flares**
  - M126 A1 Red Signal Flare: Production expected in FY12
  - Mk124 Day/Night Signal: Requires qualification and final PM approval prior to implementation

- **Perchlorate-Free Fuzes**
  - Development underway of a perchlorate-free delay for handheld signals
  - Applications in dozens of systems’ fuzes used throughout DOD with production quantities in the millions.

Take-Away Messages

- **DoD has acted responsibly regarding potential perchlorate releases**
- **Sampling continuing & response actions underway or completed, where warranted**
- **DoD does not appear to be the major source of perchlorate contamination nationwide**
  - Natural and a wide variety of non-DoD sources are likely responsible for low level, wide-spread contamination
  - New technologies can allow DoD/Regulators to identify sources
- **DoD investment in risk management measures such as treatment & substitution RDT&E continues**

Phase I Impact Assessment Completed

- ✓ **Perchlorate**
- ✓ **Hexavalent Chromium (Sept 2006)**
- ✓ **Naphthalene (Sept 2006)**
- ✓ **Trichloroethylene (TCE) (Oct 2006)**
- ✓ **1,2,3-Trichloropropane (TCP) (Nov 2006)**
- ✓ **n-Nitrosodimethylamine (NDMA) (Nov 2006)**
- ✓ **1,4-Dioxane (Dec 2006)**
- ✓ **Dinitrotoluenes (DNT) (Dec 2006)**
- ✓ **Perfluorooctanoic Acid (PFOA) (Jan 2007)**
- ✓ **Perfluorooctyl Sulfonate (PFOS) (Jan 2007)**
- ✓ **Polybrominated Diphenyl Ethers (PBDEs) (Jan 2007)**
- ✓ **Dioxins (Feb 2007)**
- ✓ **Tetrachloroethylene (PCE) (Feb 2007)**
- ✓ **Beryllium (Mar 2007)**
- ✓ **Lead (Mar 2007)**
- ✓ **RDX (Royal Demolition eXplosive) (Mar 2007)**
- ✓ **Tungsten (Mar 2007)**
- ✓ **Nickel (May 2007)**
- ✓ **Hexavalent Chromium (Jul 2007)**
- ✓ **Tungsten Alloy (Dec 2007)**
- ✓ **Sulfur Hexafluoride (SF6) (Jan 2008)**
- ✓ **Naphthalene (Apr 2008)**
- ✓ **Cadmium (May 2008)**
- ✓ **Lead (July 2008)**
- ✓ **Cerium (May 2009)**
- ✓ **Cadmium (Sept 2010)**
- ✓ **Dinitrotoluenes (DNT) (Jan 2011)**
- ✓ **Nanomaterials (Metal-Based) (Feb 2011)**
- ✓ **Manganese (May 2011)**
- ✓ **Diisocyanates (Jun 2011)**
- ✓ **Phthalate Esters (Jun 2011)**
- ✓ **Nanomaterials (Carbon-Based) (Nov 2011)**
- ✓ **Decabromodiphenyl Ether (Apr 2012)**
- ✓ **Vanadium and Compounds (Oct 2012)**
- ✓ **1-Bromopropane (1-BP) (Jan 2013)**

This summary is for chemicals on which all three parts of a Phase I Impact Assessment were completed.

Phase I Impact Assessment Results Summary

Recommended for Watch List

- Cadmium and Compounds
- Cerium ***
- Cobalt and Compounds
- Decabromodiphenyl Ether (deca-BDE)
- Diisocyanates
- Dinitrotoluenes (DNT)
- 1,4-Dioxane
- Dioxins
- Manganese and Compounds
- Nanomaterials (Metal- and Carbon-Based)
- Nickel
- Perfluorooctyl Sulfonate (PFOS)
- Tetrachloroethylene (PCE) ***
- Tungsten
- Tungsten Alloy
- Vanadium and Compounds

Dropped After Phase I

- Dichlorobenzenes
- Polybrominated diphenyl ethers (PBDEs)
- 1,2,3-Trichloropropane (TCP)

Recommended for Phase II / Action List

- Beryllium
- Hexavalent Chromium
- Lead
- Naphthalene
- Perchlorate *
- Perfluorooctanoic Acid (PFOA) **
- Phthalate Esters
- RDX
- Sulfur Hexafluoride (SF6)
- Trichloroethylene (TCE) **
- 1-Bromopropane (1-BP) *(proposed)*

Future Assessments (anticipated date)

- 1,4-Dioxane (Inhalation only) (TBD)
- n-Nitrosodimethylamine (NDMA) (TBD)
- 2,4-Dinitroanisole (DNAN) and 5-Nitro-1,2,4-triazol-3-one (NTO) (components in insensitive explosive formulations) (TBD)
- Cobalt (pending IRIS review) (TBD)

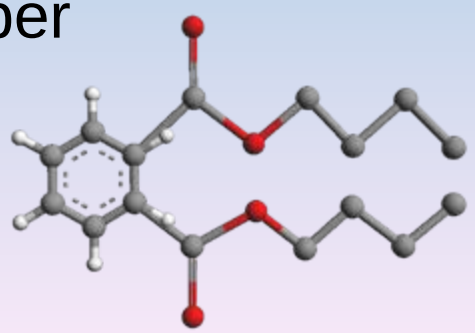
Determining Need for Phase I Assessment

- Antimony

* Demoted to Watch List in September 2010
** Subsequent Phase II Impact Assessment recommended delisting from the Action List and adding to the Watch List
*** Regulatory developments supported delisting from the Watch List

Phthalates Background

- Organic compounds derived from petroleum…phthalates are esters of phthalic acid
- Main uses:
  - Plasticizers to increase flexibility, durability and transparency of plastic products and to soften polyvinyl chloride (PVC) products
  - Solvents for oil-based dyes and nitrocellulose-based lacquers and coatings
- Due to their universally beneficial qualities, phthalates have found their way into a wide variety of consumer products
- Widespread human exposure…a number of phthalates appear in human biomonitoring surveys



Phthalates Risk Drivers

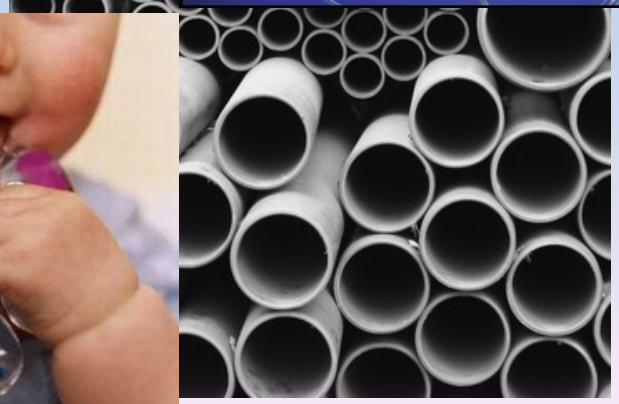
- CPSC[1] assessments and/or EPA Chemical Action Plan (CAP) for phthalates may result in requirements to label, restrict, or ban specific phthalates
- Three phthalates[2] included on the *REACH Authorisation List* (Annex XIV) cannot be placed on the market or used after 21 July 2015 without authorization
- Bottom line: Production of certain phthalates discontinued in U.S….additional suppliers may stop producing specialty phthalates critical to DoD applications
  - Time/cost intensive RDT&E needed for phthalate substitutes
  - Items made with new materials may require re-qualification

[1] Consumer Product Safety Commission

[2] BBP—Butyl benzyl phthalate; DEHP—Di(2-ethylhexyl) phthalate; DBP—Dibutyl phthalate

Phthalates Commercial Uses

- The specific phthalates in a product depends on the properties the phthalates impart and their cost
- Phthalate-containing products include:
  - **Medical supplies and devices** (i.e., intra-venous (IV) tubing and blood bags)
  - Dental materials
  - Paints, wood varnishes and lacquers
  - Anti-corrosion and anti-fouling paints
  - Wire and cable applications
  - Sealing compounds
  - Vinyl tile
  - Textiles and textile inks
  - Cosmetics
  - **Food packaging**



Phthalates Military Uses

- Solid rocket fuel binder
- Rocket motors & cartridges
- Plastics, rubber and vinyl components
- Wire insulation

- CBRN equipment (protective masks, gloves, boots, hoods) ??

Phthalates Phase I Impact Assessment

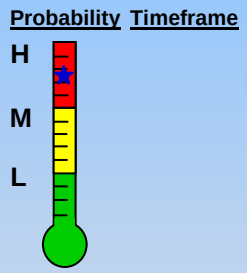
Completed June 2011

Acquisition, Technology and Logistics

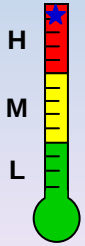
Phthalates are used as a plasticizer to create preferable physical properties in plastic products. Critical DoD phthalate-containing items include CBR equipment (protective masks, gloves, boots, hoods), propellant mixtures used in numerous munitions products, and a variety of sealers, paints, and resins.

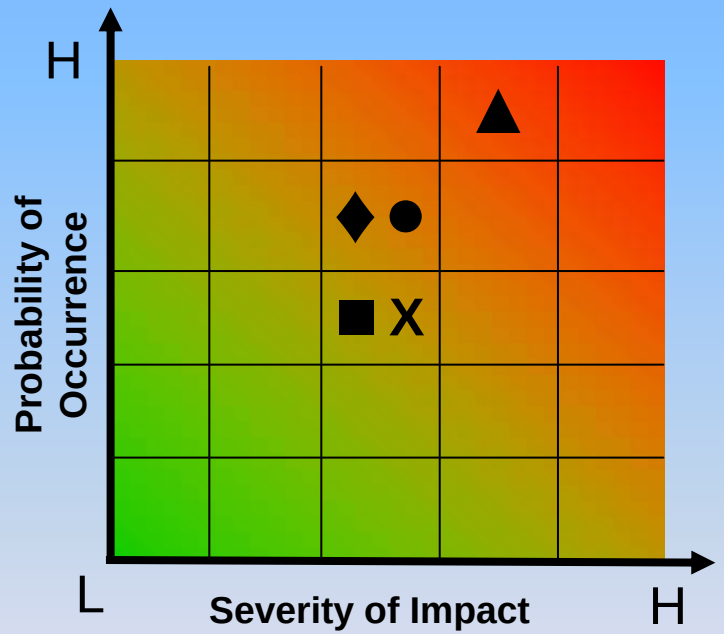
Likelihood of Toxicity Value/ Regulatory Change

1. **Probability that USEPA TSCA chemical management regulations will restrict use/availability of phthalates**



2. **Probability that EU REACH chemical management regulations will restrict use/availability of phthalates.**





- ♦ ES&H
- ■ Training & Readiness
- ▲ Acquisition/RDT&E
- ● PO&MD of Assets
- X Cleanup

Phthalates Risk Management Actions

- **Issued early Risk Alert**
- **Completed Phase II Impact Assessment**
- **Worked with Joint Program Executive Office for Chemical & Biological Defense (JPEO-CBD) to minimize risk to protective equipment**
- **Issued Risk Memo to DoD Acquisition Executives**
  - **Locate critical applications requiring phthalates**
  - **Take risk management actions (e.g., testing substitutes)**