Hexavalent Chromium Reduction in the Aerospace Industry

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14. ABSTRACT
AIA and its members have a long history in minimizing the use of hexavalent chromium in the manufacture of its products. Included in that history are the results of over 25 years of working with DoD engineering professionals through a variety of projects to test hexavalent chromium product replacements. Hexavalent chromium test data have been shared among companies within the industry since the early 1980s. Success in replacement use occurred for some sealant, primer, and plating applications. The industry continues to evaluate replacements for conversion coating, anodizing, descaling, passivation plating, cleaning and many other process and materials applications. Through the many individual company and joint research and testing programs, AIA members learned that the development and implementation of hexavalent chromium replacement compounds is exceptionally complex. Certification and qualification testing continues for many applications due to unique customer or weapon system requirements. Implementation of replacements are often hindered by cost and technical risks to a product?s other system requirements. With increasing regulatory and public pressure to further reduce hexavalent chromium usage, the aerospace industry continues to seek alternatives.

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KEYNOTE ADDRESS
HEXAVALENT CHROMIUM REDUCTION IN THE AEROSPACE INDUSTRY

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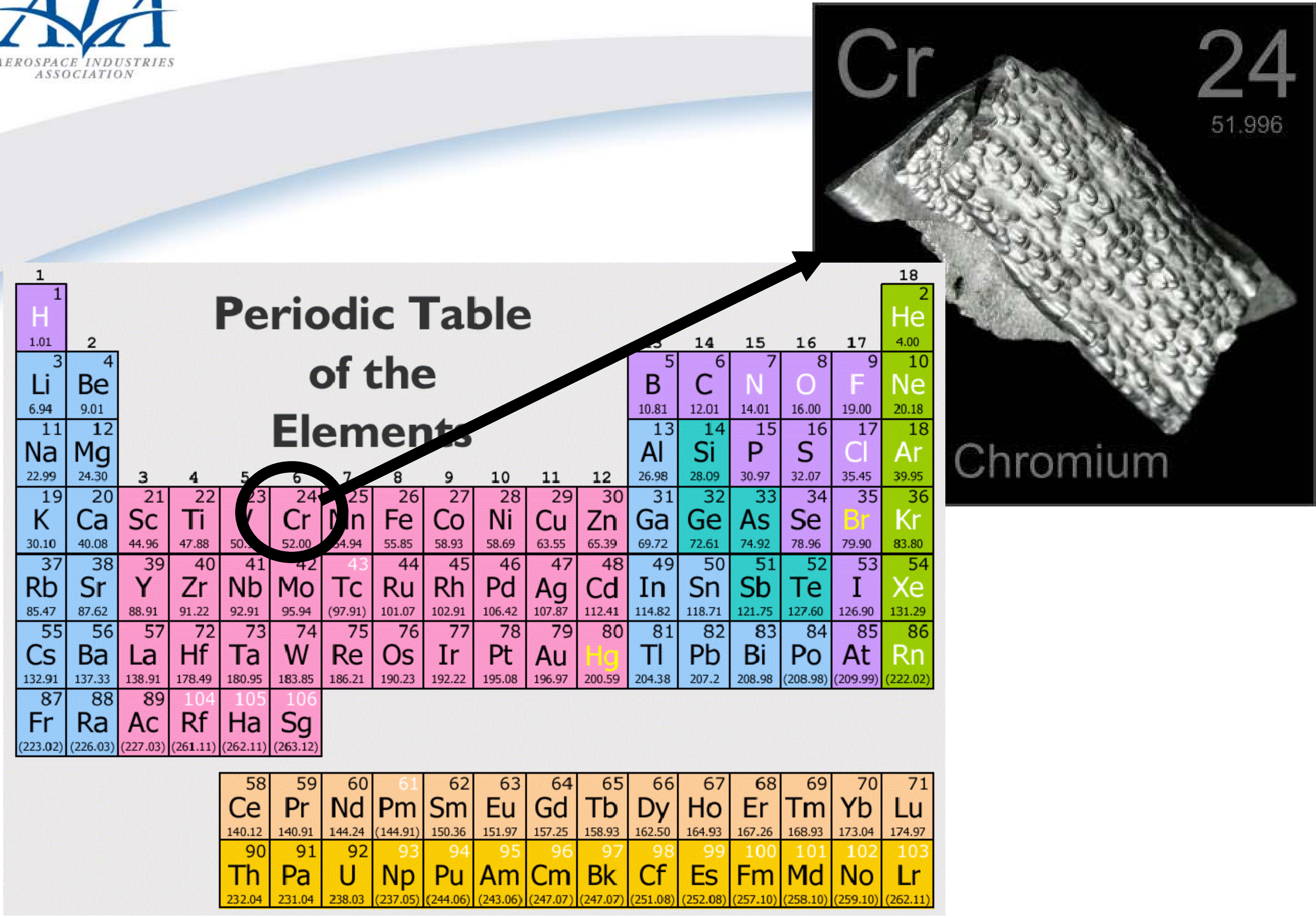
AIA
AEROSPACE INDUSTRIES ASSOCIATION



http://dickinsonn.ism-online.org/2009/09/04/periodic-table/

3rd century BC: Bronze tipped weapons found near Xian,China

- Not Corroded
- Analysis: Chromium coating

1761: Lehmann found an orange-red mineral in the Ural Mountains

- Named it: Siberian red lead.
- Chemically: lead chromate
- Popularly Known: mineral crocoite

1797-8: Vauquelin received samples of crocoite ore

- $PbCrO_4$ + hydrochloric acid (HCl)→ chromium oxide CrO_3
- Isolated Metallic Chromium: CrO_3 + Heat → Cr

1800: Tassaert found chromium in an ore: chromite ($PbCrO_4$)

- Lead Chromate: Today a major source of chromium.

1800's:Usage: Component: paints and tanning salts

Today: Usage:85-95%: metal alloys (aerospace,automotive)

5-15 % : chemical, refractory & foundry industries.

Why is Hex. Chrome Used Today?

- High performance anti-corrosive
- Moisture Barrier
- Components must withstand:
  - Extreme temperature
  - Altitudes
- Atmospheric and Temperature Changes
- Repeated Take-off and Landings
  - Repeated Speed and acceleration changes

50+ Year History in Aerospace Industry

- Applied to Structures
- Coatings
- Pre-coating treatment for metal parts
- Chemical conversion coatings with aluminum and aluminum alloy
  - MIL-DTL-5541F,
- Anodizing
- Electroplating

Worker Safety Exposures

1. Irritation/damage to the nose, throat, and lung (respiratory tract)

2. Irritation/damage to the eyes and skin from contact

3. Acute Toxicity
   - Kidney, Liver and Blood Cell damage

4. Carcinogenicity
   - Lung Cancer in workers: airborne ingestion

In United States:

1. Environmental Protection Agency (EPA)
    1. Clean Air Act (CAA)
        - Hazardous air pollutant (HAP) in accordance with the Aerospace National Emission Standards for Hazardous Air Pollutants (NESHAP)
        - Safe Drinking Water Act
2. Occupational Safety and Hazard Administration (OSHA)
    - Worker Protection Permissible Exposure Limit
3. DoD
    - Minimization Policy→ Proposed Contract limits (DFAR)

In the European Union EU:

1. REACh
    a) Candidate list
        - PbCrO3,
        - NaCrO3
        - KCrO3 and
        - 2K 2(CrO3)

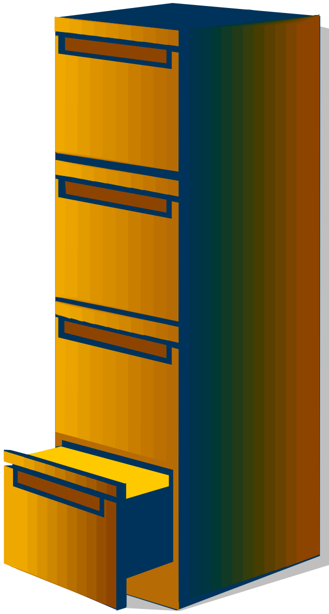
Reduction to Date

Content Reductions

\+ Coating Substitutions

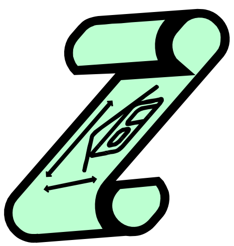
\+ Tri-Chrome Introductions

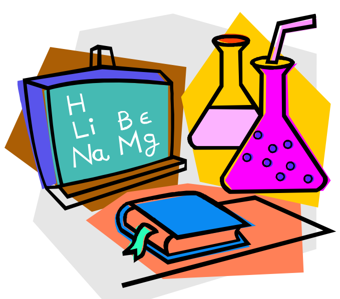
Total = Difficult to Quantify (few baseline records)



Barriers to Reductions

1. Human Resistance
2. Product Performance Requirements
3. Cost/Funding
    a. Research
    b. Qualify/Performance Testing
    c. Scale Up: Bench→ Pilot→ Production
4. Specifications and Standards
    a. Military/Industry/Contract
5. Lack Documentation for all Applications
    a. Supply chain data uncertain
    b. No Requirements to provide complete composition data
    c. Proprietary Formulas





"Drop In Replacement" vs. "Alternative Strategy"

- Preferred Mode
- Not always Possible
- Domino Effect (One change here→ other changes elsewhere in product or process)

Engage all stakeholders

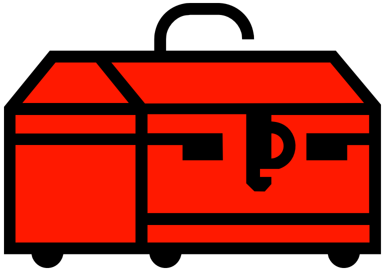
1. Identify all Stakeholders
   i. Customers
   ii. Designers
   iii. Contracts/Logisticians
   iv. Materials Engineers
   v. Environmental
   vi. Health and Safety
2. Identify and Track Uses/Applications
3. Assess Impacts
4. Performance Requirements
5. Risks
6. Alternatives
   i. Material
   ii. Process
   iii. Performance

Manage Chemical Management Changes

- Regulatory Restrictions
- Obsolescence
- Market Changes
- Availability

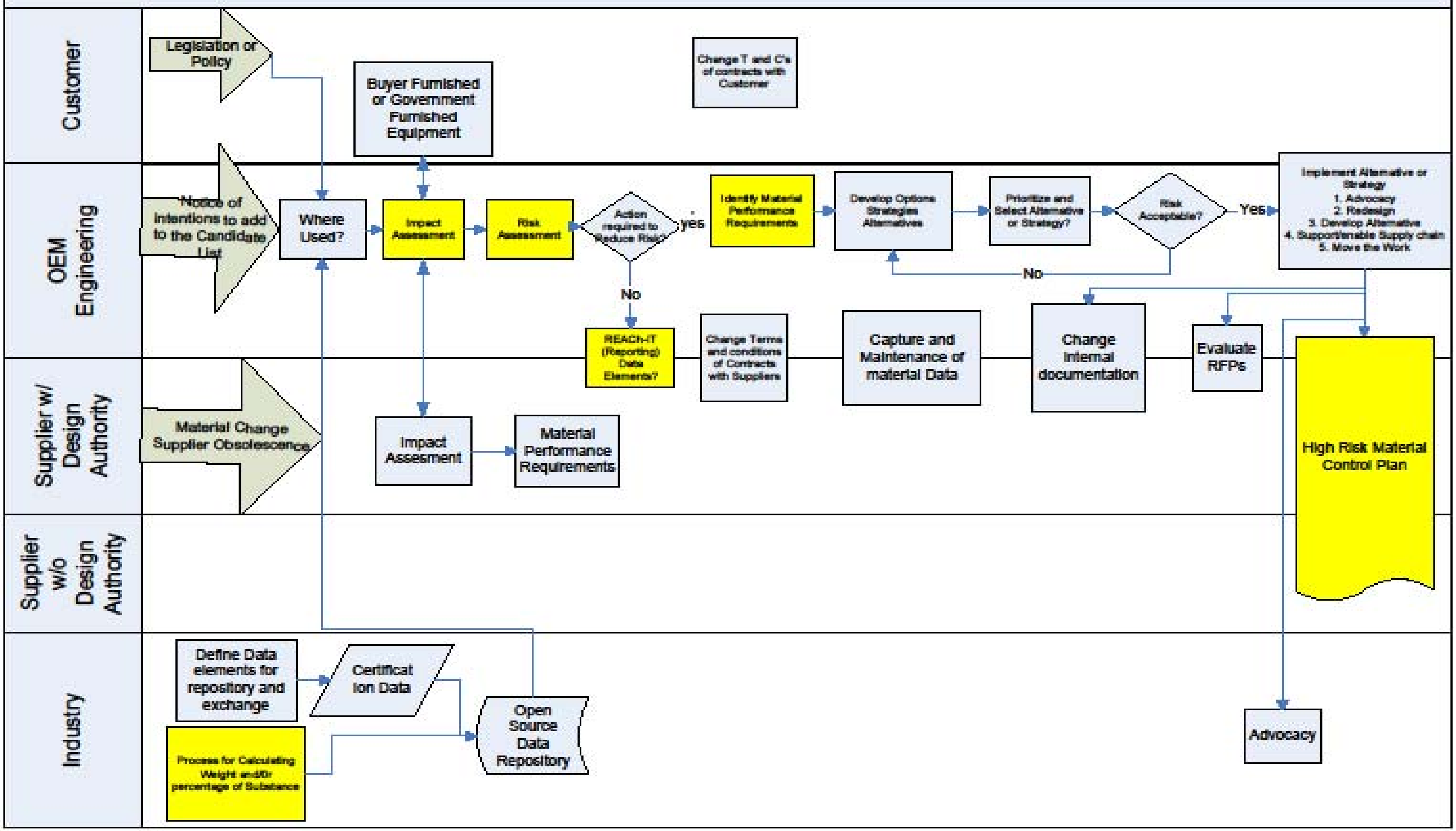
Need Tools to Predict Changes

- IT Guidelines
- Engineering Plan/Scenario

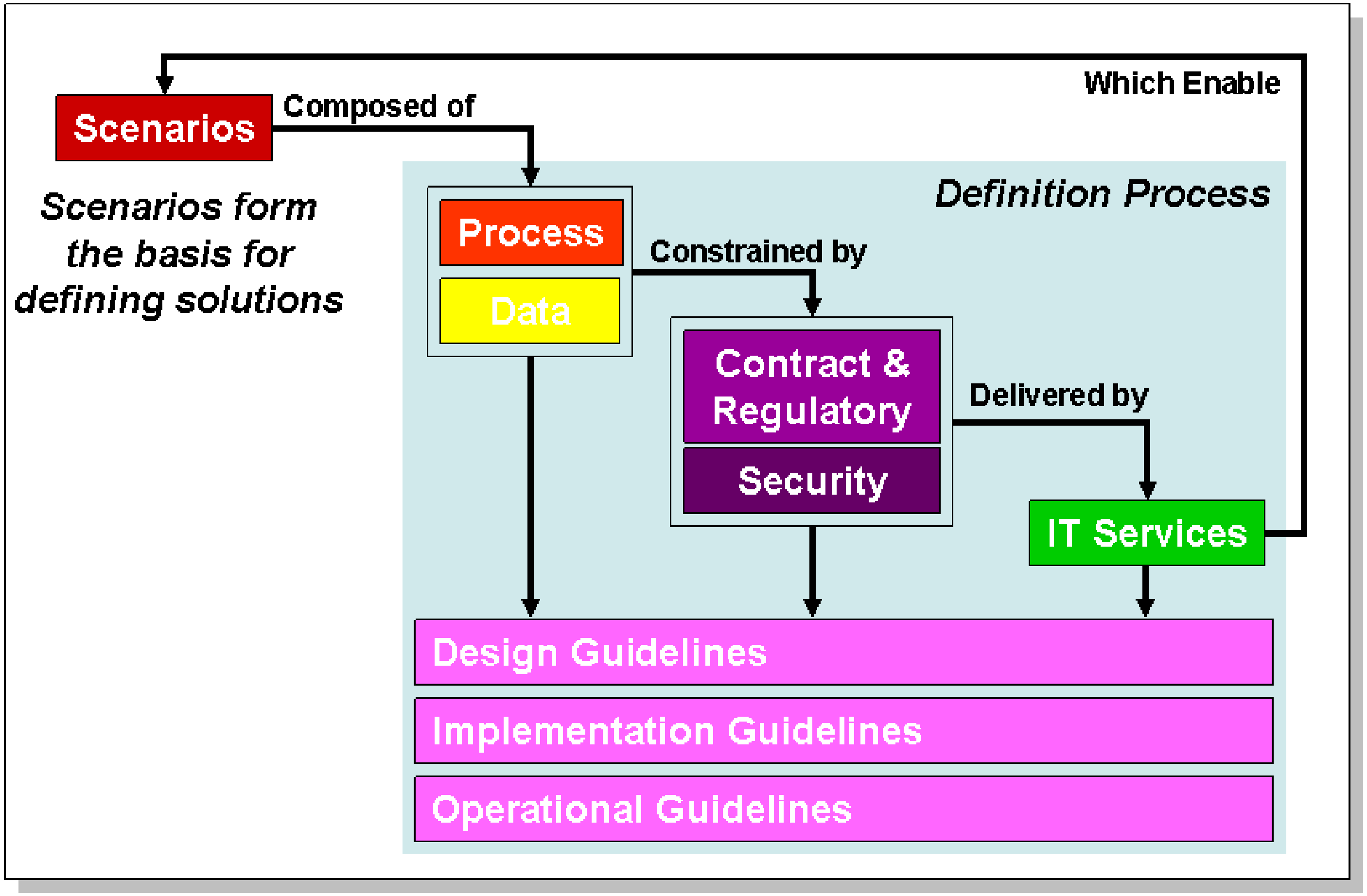


AIA REACH Engineering Scenario

REACh – Engineering Scenario for a change in Material requirement due to an external influence such as: Regulatory Mandate, availability, or Market Forces; perceived or otherwise



Delivering Business Solutions



AIA Members participate in:

1. The Aerospace Chrome Eliminate Project
   a. Sealant
   b. Primer
   c. Plating Application
2. NASA –TEERM (Technology Evaluation for Environmental Risk Mitigation)
   - Coating Systems (Pretreatment, primer and topcoat) for avionic applications
3. DoD Programs
   - Lockheed Martin and the F-35
     - *Primers*
4. AIA Material Working Group
5. Individual Corporate Programs

New Venues for Alternative Activity

1. DoD/NASA/AIA Sustainable Materials Management 2010 Workshops
   - Next Steps: Planning Stages
   - Identify Opportunities for Collaboration

2. AIA/ASD REACH Engineering Alternatives 2010 American/European Collaboration on Alternatives
   - 2010 Workshop in Toulouse Fr:
   - Best Practice Sharing
   - Next Steps: Identify Collaborative Opportunities

Conclusion

- Need for Hexavalent Chromium Alternatives Growing
- Replicating Performance: Significant Hurdle
- Solid and Large Body of Work to Build Upon
- Baseline Existing Work
- Collaboration Recommended
  - Across Industry/Gov't/Academia
- Develop Tools and Process to Guide Efforts
  - IT and Engineering
- Lessons Learned will be Needed for the Next Chemical/Substance Target