

# Air Force Materiel Command

## 27th Annual Systems and Mission Engineering Conference:

### Artificial Intelligence HazMat Search Project Summary



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**31 Oct 2024**

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# Overview

- **What is AI?**
  - **Films / Documentaries**
  - **Deep Blue / AlphaGo**
- **Foreign Threat / DoD Strategy / Goals**
- **Project Background**
  - **HazMat Concerns / Working Group**
  - **Initial SBIR Effort**
  - **Army application / BAH AI service**
- **Summery**
  - **Pilot-project results**
  - **1<sup>st</sup> Year Follow-on results**
  - **2<sup>nd</sup> Year Follow-on plans**
- **Conclusion**



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# ***ARTIFICIAL INTELLIGENCE***



# What is AI/ML?

- **Artificial Intelligence (AI) – simulated intelligence demonstrated by computers/machines, in contrast to the natural intelligence displayed by humans**
- **Machine Learning (ML) - computer algorithms that improve automatically through experience, it learns**

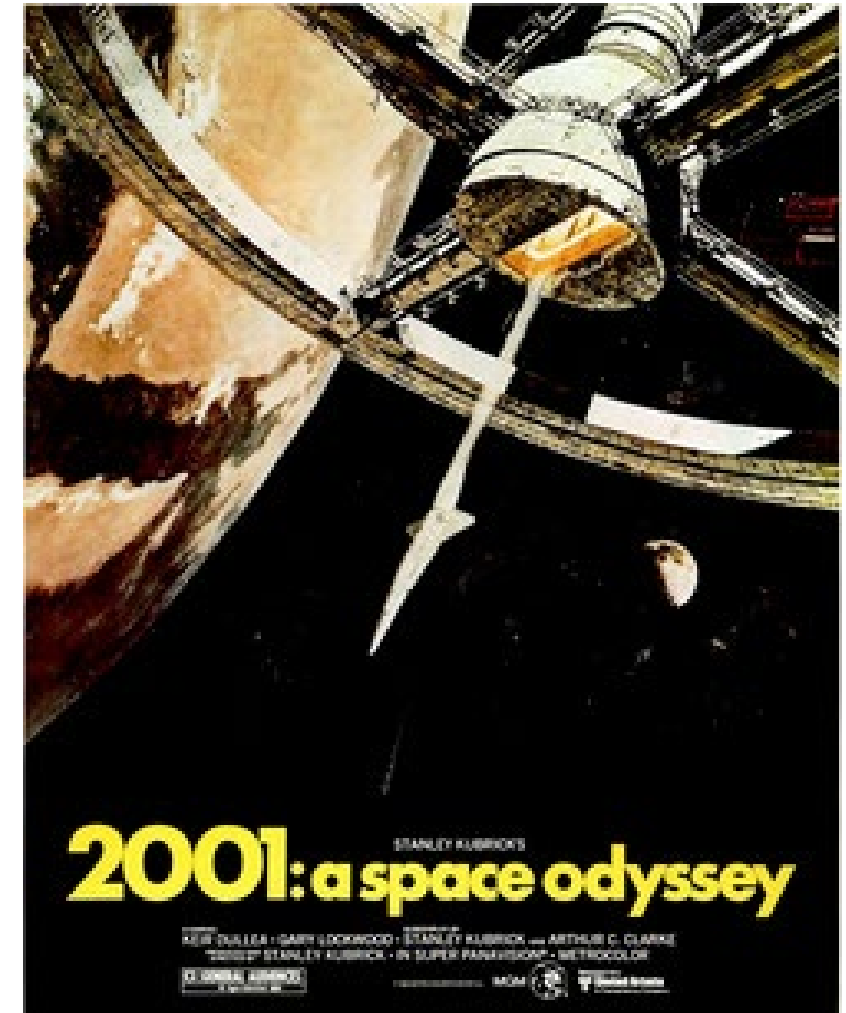


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# AI in Science Fiction

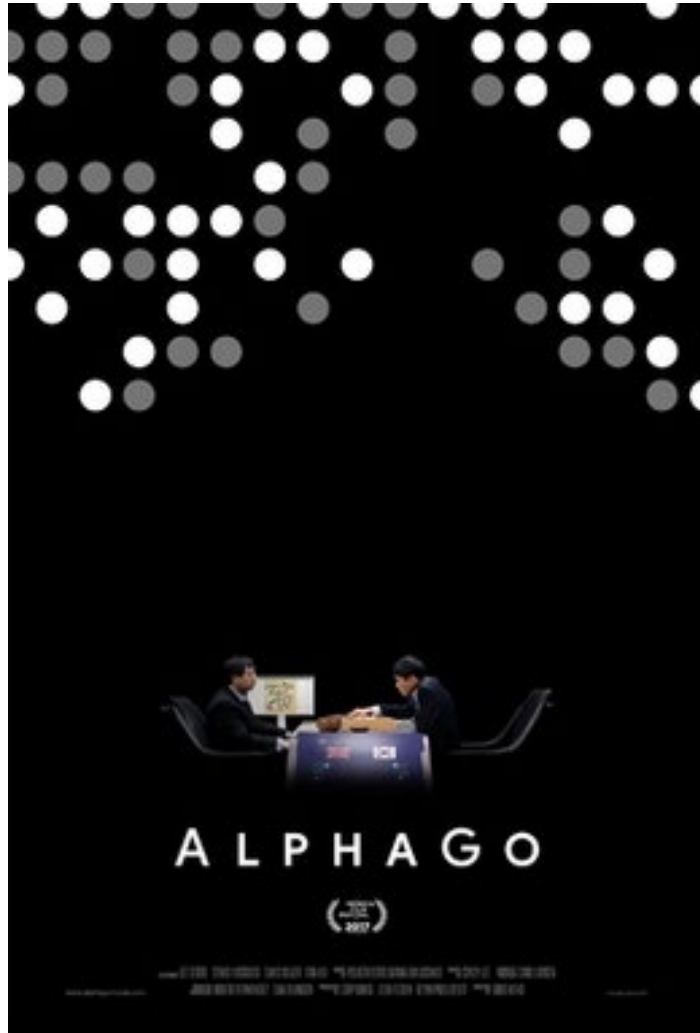
- **Wikipedia List of artificial intelligence in films**  
[https://en.wikipedia.org/wiki/List\\_of\\_artificial\\_intelligence\\_films](https://en.wikipedia.org/wiki/List_of_artificial_intelligence_films)
- **2001: A Space Odyssey (1968, Dir. Stanley Kubrick)**  
After uncovering a mysterious artifact buried beneath the Lunar surface, a spacecraft is sent to Jupiter to find its origins - a spacecraft manned by two men and the supercomputer H.A.L. 9000.  
IMDB: <https://www.imdb.com/title/tt0062622/>  
Wiki: [https://en.wikipedia.org/wiki/2001:\\_A\\_Space\\_Odyssey\\_\(film\)](https://en.wikipedia.org/wiki/2001:_A_Space_Odyssey_(film))
- **Terminator 2: Judgement Day (1991, Dir. James Cameron)**  
Earth is a wasteland dominated by the war between the malevolent artificial intelligence (AI) Skynet and the human resistance.  
IMDB: <https://www.imdb.com/title/tt0103064/>  
Wiki: [https://en.wikipedia.org/wiki/Terminator\\_2:\\_Judgment\\_Day](https://en.wikipedia.org/wiki/Terminator_2:_Judgment_Day)
- **Ex Machina (2015, Dir. Alex Garland)**  
A young programmer is selected to participate in a ground-breaking experiment in synthetic intelligence by evaluating the human qualities of a highly advanced humanoid A.I.  
IMDB: <https://www.imdb.com/title/tt0470752/>  
Wiki: [https://en.wikipedia.org/wiki/Ex\\_Machina\\_\(film\)](https://en.wikipedia.org/wiki/Ex_Machina_(film))



Metro-Goldwyn-Mayer image from Wikipedia, Use of the poster art in the article complies with Wikipedia non-free content policy and fair use under US copyright law as it is a low-resolution image.



# AI Documentaries



- **“AlphaGo” (2017)**  
Documentary about the Google DeepMind Challenge Match with top-ranked Go player Lee Sedol.  
<https://www.alphagomovie.com/>  
<https://www.youtube.com/watch?v=WXuK6gekU1Y>
- **FRONTLINE “In the Age of AI” (2019)**  
Investigates the promise and perils of artificial intelligence.  
[www.pbs.org/wgbh/frontline/film/in-the-age-of-ai/](http://www.pbs.org/wgbh/frontline/film/in-the-age-of-ai/)  
[https://www.youtube.com/watch?v=5dZ\\_lvDgevk](https://www.youtube.com/watch?v=5dZ_lvDgevk)
- **“The Social Dilemma” (2020)**  
How social media manipulates people's views, and spreads conspiracy theories and disinformation, to maximize profit. Dangers of AI and fake news.  
<https://www.thesocialdilemma.com/>  
<https://www.netflix.com/title/81254224>

AlphaGo image from Wikipedia, Use of the poster art in the article complies with Wikipedia non-free content policy and fair use under US copyright law as it is a low-resolution image.



# AI Defeats Humans in Chess and Go



1996-97: IBM Chess Computer Deep Blue beat World Chess Champion Garry Kasparov.



Google's DeepMind AlphaGo became the first computer Go program to beat human professional Go players.

2015: Fan Hui (2P), 2016: Lee Sedol (9P), 2017: Ke Jie (9P)

DeepMind retired AlphaGo from competition to focus on medical and scientific research.

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# Foreign AI Threat

## ■ China

- Success of AlphaGo was a "Sputnik moment" which helped convince the Chinese government to prioritize and dramatically increase funding for artificial intelligence
- Applications for guided missiles, tracking people, censorship, cyberwarfare applications
- Ahead of U.S. in AI research (funding, articles published)
- In 2019 Launched country wide facial recognition system called "Skynet" using 200 million cameras, claims it can identify the entire population of China with 99.8% accuracy
- Plans to become AI world leader by 2030

## ■ Russia

- Cyberwarfare applications, data and imagery collection and analysis
- Applications for unmanned aerial and ground combat systems, swarm testing
- First weaponized use of deepfake during an armed conflict ("Zelensky surrendering")
- Putin: "Artificial intelligence is the future... Whoever becomes the leader in this sphere will become the ruler of the world."





# DoD leadership is adopting AI across the enterprise

- **2018 - Joint Artificial Intelligence Center (JAIC) established to accelerate AI-enabled capabilities**
  - Deliver AI-enabled capabilities that address key missions
  - Scale AI's impact across DoD
  - Cultivate a leading AI workforce
  - Engage with commercial, academic, and international allies and partners
  - Lead in military ethics and AI safety
- **2022 - JAIC, the Defense Digital Service, and the Office of Advancing Analytics were merged into The Chief Digital and Artificial Intelligence Office (CDAO)**
  - USAF Sec Frank Kendall: Move AI in to field fast, while applying ethical considerations
  - CDAO website: <https://www.ai.mil>
- **2023 DoD AI Adoption Strategy**  
[https://media.defense.gov/2023/Nov/02/2003333300/-1/-1/1/DOD\\_DATA\\_ANALYTICS\\_AI\\_ADOPTION\\_STRATEGY.PDF](https://media.defense.gov/2023/Nov/02/2003333300/-1/-1/1/DOD_DATA_ANALYTICS_AI_ADOPTION_STRATEGY.PDF)
- **2025 S&T AI Request alone is \$4.9B**  
<https://www.meritalk.com/articles/dod-prioritizes-ai-space-tech-sensing-cyber-in-st-funding-plans/>



Image: <https://www.ai.mil>



# AFMC Program

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## ■ Goals

- Document AI applications/threats related to National Security
- Document AI applications of interest to AFMC
- Work with Program Offices to identify/document AI applications
- Collaborate with AFMC centers to establish enterprise evaluation capability of embedded weapon systems AI applications
- Maintain awareness of advances in AI
- Resilient Sustainment Support
- Ethical AI development for enduring decision advantage

## ■ Activities

- HazMat search pilot-project and follow-on projects



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# ***HAZMAT***



# HazMat Concerns

- **AFMC Commander chaired the AFMC ESOH Council (ESOHC)**
- **Goal: Eliminate hazardous materials that impact the safety and health of all AFMC personnel**
- **Specifically concerned with replacing Hexavalent Chromium (HexCr)**
- **AFMC HMR Governance Board & IPT was formed as an ESOHC action item in 2015 to address enterprise level ESOH risks**
- **Non-Chromium Action Plan (N-CAP) was an HMR GB initiative launched in 2021**
- **N-CAP has completed its assigned charter, and a HexCr IPT is being stood up to continue the efforts to manage HexCr**
- **GB and IPT meet semi-annually**
  - **IPT Working Group meets weekly**

ESOH – Environment, Safety & Occupational Health; HMR GB/IPT – Hazardous Material Reduction Governance Board / Integrated Production Team; WG – Working Group



# Top 20 HazMat List

1. Benzene
2. Beryllium
3. Cadmium
4. Freon
5. Halon
6. Hexavalent Chromium
7. Iron Carbonyl
8. Isocyanates
9. Lead
10. Mercury
11. Methanol
12. Methyl-cyclohexane
13. Methyl Ethyl Ketone
14. Nickel
15. PD-680
16. Sulfur Dioxide
17. Tetrachloroethylene
18. Toluene
19. Trichloroethane
20. Xylene

**Used as primers, sealants, coatings.  
Many are known carcinogens.  
Exposure has caused illness to several USAF  
aircraft maintenance workers, and one death.**

Ref: <https://accas.info/archives/2261>



# ***AFMC HMR Project SBIR proposal on HazMat Keyword Search***

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## **TITLE: Intelligent Search of Documents for HazMat References**

- **Seeking technology for keyword search for any references to hazardous materials**
  - **Documents, drawings, spreadsheets, Bill of Materials (BOMs), technical orders, etc.**
  - **Include scanning images**
  - **Include all HazMat name variations (Cr<sup>6+</sup>, Cr(VI), Hex Chrome, Ch VI, Ch 6, Chrome 6)**
  - **Potentially large directories, with hundreds or thousands of documents (JEDMICS)**
- **Identify HazMat with document file names, part numbers, systems, subsystems, programs**
- **Anticipate requiring Artificial Intelligence (AI) and Machine Learning (ML) algorithms**
- **Status: Submitted/approved as Pitch Day topic (Jan 2021)**
- **POC: Mr. Mark Fraser**

HazMat – Hazardous Material; SBIR – Small Business Innovation Research; BOM – Bill of Material;  
JEDMICS – Joint Engineering Data Management Information and Control System



# Army/Marine/JPO Efforts

- U.S. Army, Marine Corps, and JPO- F35 is using Booz Allen Hamilton's (BAH) Data Reconnaissance™ program, an AI search capability to track down components with toxic plating in watercraft, jet, transports and tanks. There may be thousands of parts on any single platform, and many common ones across platforms, that use toxic metals for corrosion resistance, wear resistance, and part refurbishment.

Fasteners



Other Parts



Connectors (long-lead)



Depot Reclaimed Parts



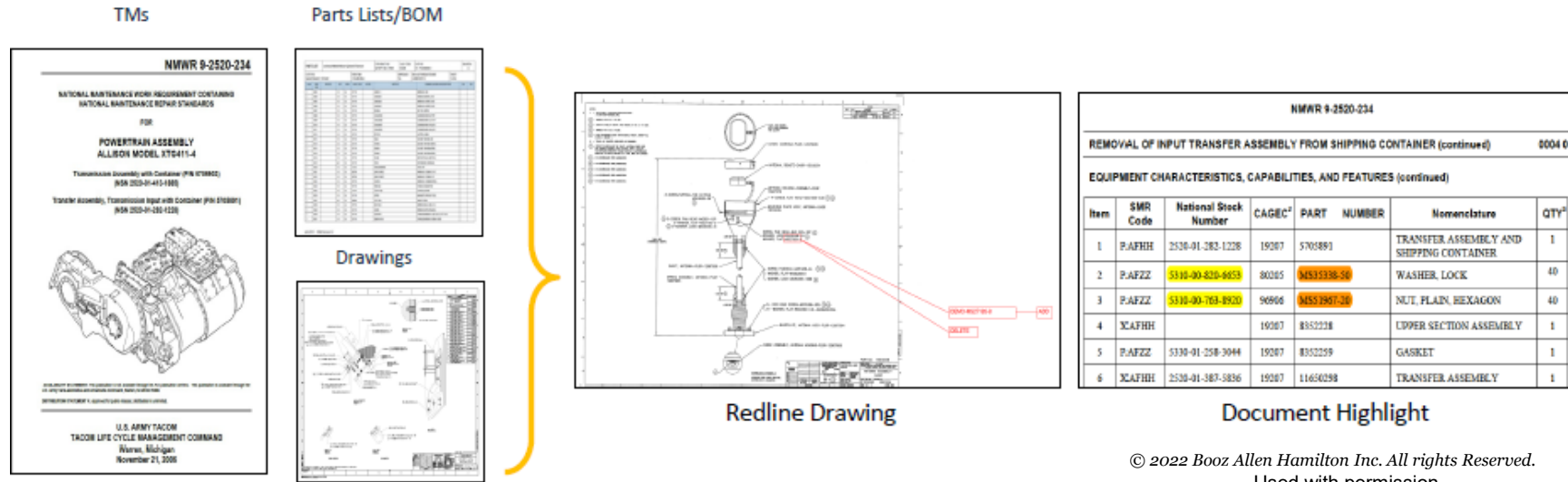
Gun Barrels (long-lead)



Images from US Army, L. Graf. Used with permission.



# BAH AI System— Automated Technical Document Alterations



Identify

&

Update

- Works with data from systems of record, such as FLIS, JEDMICS, A Team and LCMP
- Automatically redbox & highlights technical documents for the Engineering Change Process (ECP)
- Works with Interactive Electronic Technical Manuals (IETMS)
- Automatically updates thousands of pages of TMs, NMWRs, DMWRs, RPSTLs, and other logistics documentation
- Leverages Natural Language Processing (NLP) to learn historical variations of Parts and Names
- Learns and improves overtime from Subject Matter Experts input

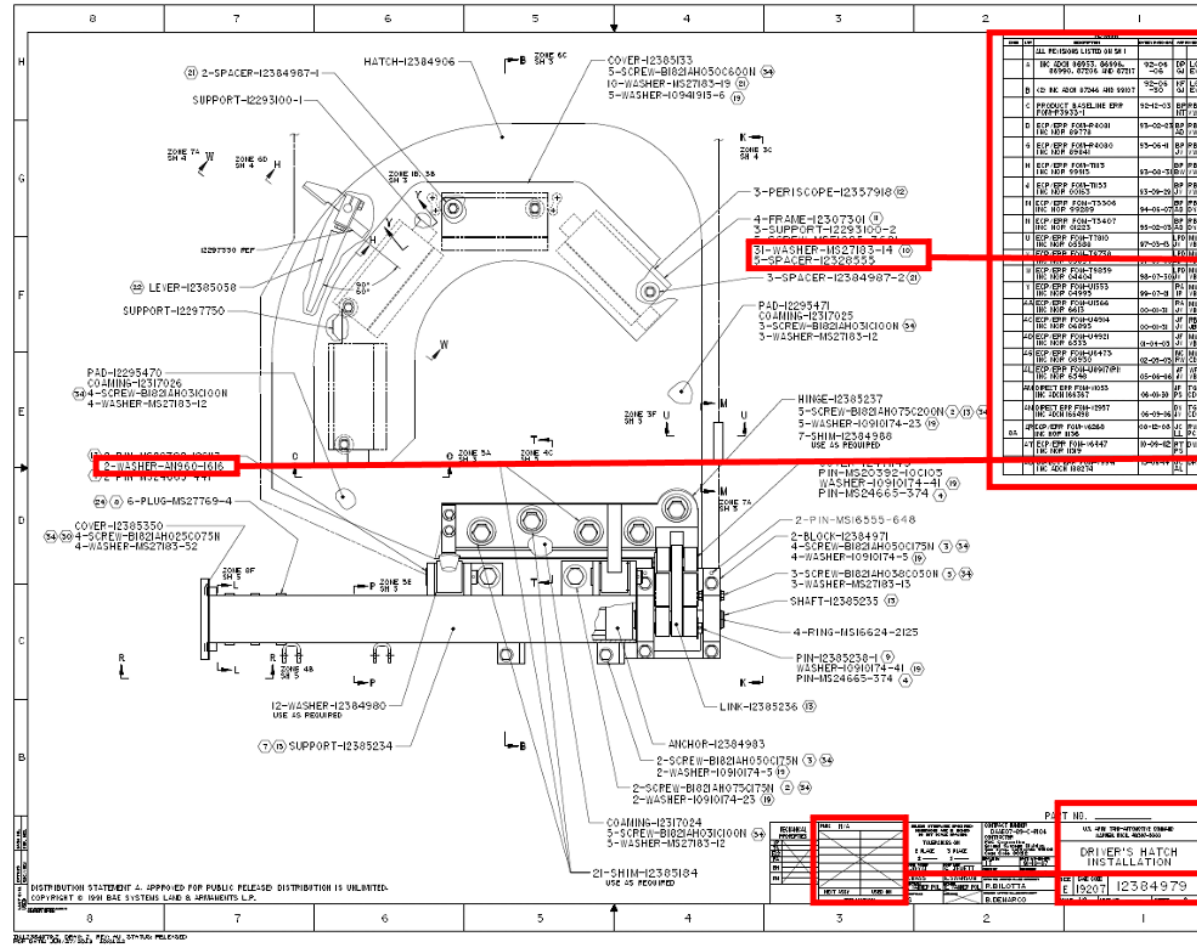
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# BAH AI System— Automated Cognitive Support of ECPs

- AI review of drawing Requirements
- Once trained, reviews batches of engineering drawings in hours instead of months
- 21,220 manual hours versus 15 hours by AI per a batch of 1000 drawings
- Identify inconsistencies between drawings and systems of record to facilitate human review.



Review Tables  
Revisions, Parts &  
Titles

Review Parts for  
accuracy & action

Review Revision and  
Drawing Information

Review Next  
Assembly

ECP – Engineering Change Proposal

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# AFMC HMR Project “AFMC HazMat Intelligence”

## ■ Description

- AI service –
  - Pilot-project: Top 20 HazMAAt (ALCM, MMIII)
  - 1<sup>st</sup> Year: Top 20 HazMAAt (MMIII)
  - 2<sup>nd</sup> Year: Identify all hazardous materials as defined by the NAS411-1 (MMIII)
- Programs can mitigate / replace with safer materials
- Automated redbox drawings. Output can be loaded back into JEDMICS.
- Enhance engineering change process, configuration management, sustainment
- Save lives, prolong DoD workforce health
- Analyzing preliminary data for: Minuteman III Missile System (MMIII)

## ■ Schedule

- \$1M MIPRs to BAH for 12-mo
- Pilot-project contract awarded Jul’21
- 1<sup>st</sup> Follow-on contract awarded Aug’23
- 2<sup>nd</sup> Follow-on contract awarded Aug’24



BAH – Booz Allen Hamilton; MIPR – Military Interdepartmental Purchase Request



# AFMC HMR Project

## “AFMC HazMat Intelligence”

- **MMIII Follow-on Year 1 Results:**
  - 9,013 pages of documents evaluated, resulting in 14,647 individual parts ingested
  - Unique parts were found to contain hazardous materials
  - Cadmium / HexChrom & Cadmium most prevalent of all substances identified
- **Time comparison: 40 man-hours (ALCM benchmark) vs 5 Minutes (AI) per a batch of drawings**
  - For Army customer, it has saved \$100K’s + years of work

TMs

Parts Lists/BOM

Drawings

Redline Drawing

Document Highlight

Item	SMR Code	National Stock Number	CAGEC <sup>2</sup>	PART NUMBER	Nomenclature	QTY <sup>3</sup>
1	PAFHH	2520-01-282-1228	19207	5705891	TRANSFER ASSEMBLY AND SHIPPING CONTAINER	1
2	PAFZZ	5310-00-820-6653	80205	MS35338-50	WASHER, LOCK	40
3	PAFZZ	5310-00-763-8920	96906	MS1967-20	NUT, PLAIN, HEXAGON	40
4	XAFHH		19207	8352228	UPPER SECTION ASSEMBLY	1
5	PAFZZ	5330-01-258-3044	19207	8352259	GASKET	1
6	XAFHH	2520-01-387-5836	19207	11650298	TRANSFER ASSEMBLY	1

BAH – Booz Allen Hamilton; BOM – Bill of Material; TM – Technical Manual; EO – Engineering Order



# AFMC HMR Project

## “AFMC HazMat Intelligence”

### Master HazMat Database

Unique hazardous part numbers / spec numbers have been identified in MMIII HBOMs, Tech Manuals, Drawings, and Engineering Orders.

Hazardous Material	Count
Benzene	
Benzene / Xylene	
Benzene / Cadmium / Hexavalent Chromium	
Benzene / Hexavalent Chromium / Toluene / Xylene	
Benzene / Hexavalent Chromium / Xylene	
Benzene / Xylene	
Beryllium	
Cadmium	
Cadmium / Hexavalent Chromium	1 <sup>st</sup> peak
Cadmium / Hexavalent Chromium / Methyl Ethyl Ketone (MEK) / Toluene / Xylene	
Cadmium / Hexavalent Chromium / Nickel	
Cadmium / Hexavalent Chromium / Zinc (II)	
Cadmium / Nickel	
Freon	
Hexavalent Chromium	2 <sup>nd</sup> peak
Hexavalent Chromium / Methyl Ethyl Ketone (MEK) / Toluene / Xylene	
Hexavalent Chromium / Nickel	
Hexavalent Chromium / Nickel / Toluene	
Hexavalent Chromium / Toluene	
Hexavalent Chromium / Toluene / Xylene	
Hexavalent Chromium / Xylene	
Hexavalent Chromium / Zinc (II)	
Lead	
Mercury	
Nickel	
PD-680	
Tetrachloroethylene	
Toluene	
Toluene / Xylene	
Xylene	
Zinc (II)	



# *Follow-On Plans*

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- **MMIII – Follow-on project is continuing BAH/AI search of all defined NAS411-1 chemicals in 800,000+ drawings (Eventually expand to other USAF and Navy systems)**
- **MMIII - Potential project for BOM building off the 800,000+ drawings**
- **F 35 - Project continuing with OEMs to identify hazmat with sub tier 1 suppliers**
- **AFMC - Discussion on potential ways to offer as a service to PMs**



# *HazMat Replacement Plans*

- **AFMC HMR GB recommend and AFMC ESOH Council completed a Non-Cr Action Plan (N-CAP) readiness assessment. Phase 3 efforts were completed on LCMC & other AF munitions and ground-based systems.  
(similar to the N-CAP efforts completed for aircraft outer mold line project)**
  
- **AFMC HMR IPT is actively working with subject matter experts on an initiative to replace Cadmium plated fasteners with superior Zn-Ni plated fasteners for use on aircraft, ground support equipment, and other weapon systems**
  
- **Candidates to replace HexCr are being investigated**
  - **Organic coatings (COTS chrome-free primers)**
  - **Inorganic (metallic) coatings**
  - **Trivalent-Chromium (Tri-Cr) pre-treatment**

Cr – Chromium; Zn-Ni – Zinc-Nickel; HexCr – Hexavalent Chromium; COTS – Commercial off-the-shelf



# *Future SPO Involvement*

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- **Partner with SPOs to leverage AI capabilities**
  - **Encouraging Programs to budget early for AI contract**
- **Programs can use AI as a service**
  - **AFMC using AI to identify HazMat in ALCM, MMIII**
  - **U.S. Army using AI to identify HazMat in howitzers, tanks**
  - **Other AI applications:**
    - **Program-specific spin-offs resulting from pilot-project (MMIII)**
    - **Counterfeit parts identification (Fraud WG)**
    - **Identify outdated parts**
    - **Supply chain risk management**
    - **Engineering Change Proposals (ECP)**
    - **Automated drawing updates**
    - **Obsolescence management**
    - **Part commonality assessment**



# *Alternate Funding - CTMA*

- The Commercial Technologies for Maintenance Activities (CTMA) Program offers a unique contracting vehicle for industry, academia, and the DOD sustainment community to work in collaboration to promote the development, demonstration, and transition of new and innovative technologies which enhance warfighter readiness at optimal value and lowest risk. This non-FAR based contracting vehicle is the only DOD-wide program focused solely on maintenance and sustainment.
- **COST SHARE:** Initiatives include cost share from each partner, so all parties have an investment in a positive outcome.
- **SPEED TO CONTRACT:** 45-90 days from Military Interdepartmental Procurement Request (MIPR) to contract modification.
- **PROJECT MANAGEMENT:** The respected NCMS team is experienced and connected to the DOD maintenance and sustainment communities.
- **CONTACT:**

Debbie Lulu

NCMS, CTMA Program Director

debral@ncms.org

734-262-0758

National Center for Manufacturing Sciences

3025 Boardwalk

Ann Arbor, MI 48108

<https://www.ncms.org/ctma/>

The CTMA Program is a cooperative agreement in partnership with the Office of the Deputy Assistant Secretary of Defense, Material Readiness (ODASD-MR).





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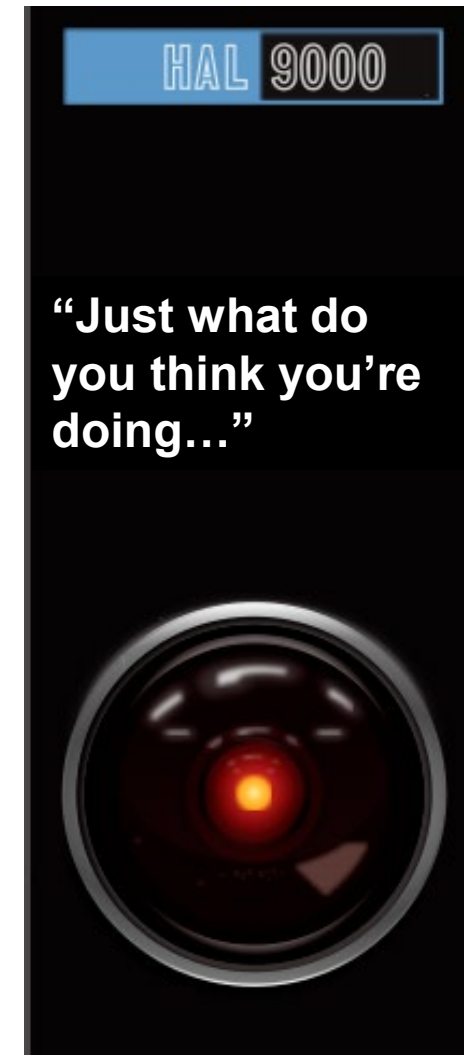
# ***CONCLUSION***



# Conclusion

- AI search capability exists as a service
- AFMC using AI to search HazMat
  - ALCM / MMIII
  - Saves time & money
  - Goal: Save lives/health of personnel
- Other search applications possible
- Budget early
  - Alternate funding is available (CTMA)

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“Just what do you think you’re doing...”



# Points-of-Contacts

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- **Technical Manager (pilot-project only)**
  - **Mark D. Fraser, NH-03 USAF AFMC, mark.fraser.5@us.af.mil**
  
- **Contact info available on request:**
  - **MMIII Program participant & follow-on project POC**
  - **ALCM Program participant**
  - **Army Customer of BAH AI Service**
  - **BAH AI service POC**
  - **AFMC Hazardous Material Reduction (HMR)  
Integrated Product Team (IPT) Working Group**

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