Chemical & Biological Defense Program Physical Science & Technology "Rethinking" Decontamination

Mark T. Mueller
Hazard Mitigation Thrust Area Manager
24 October 2007

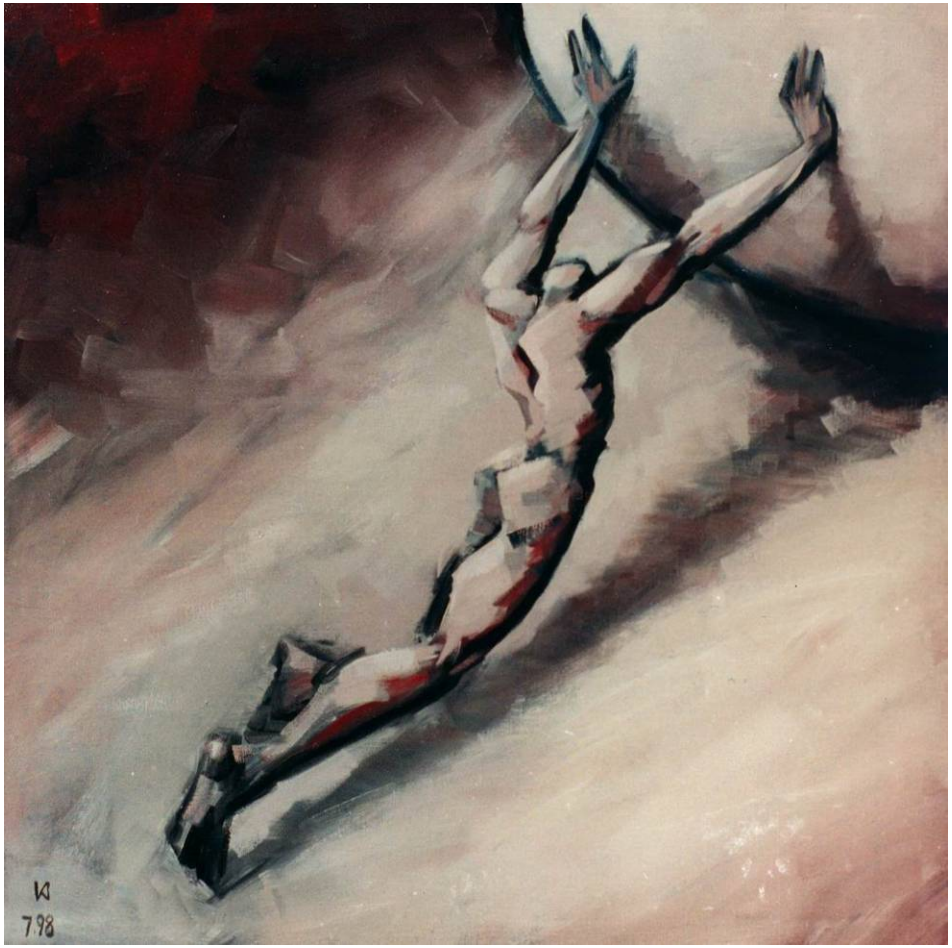
Preface

- In April, 2007 the Joint Science and Technology Office for Chemical and Biological Defense programmatically realigned the legacy Decontamination Capability Area as the Hazard Mitigation Thrust Area under the Protection Capability Area
- In spite of published doctrine “decontamination” is an often misunderstood concept and does not accurately describe military missions, capabilities, and objectives
- The views and opinions expressed here are solely those of the author and do not necessarily represent the views of the U. S. Department of Defense

Agenda

- Perspective
- The Problem Statement
- “Universal Decon”
- Rethinking Decon
- The Battlefield Environment
- The Human Element
- Next Steps in Hazard Mitigation
- Summary

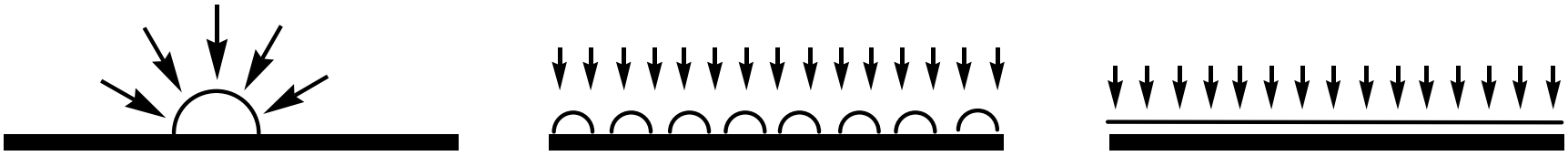
Perspective



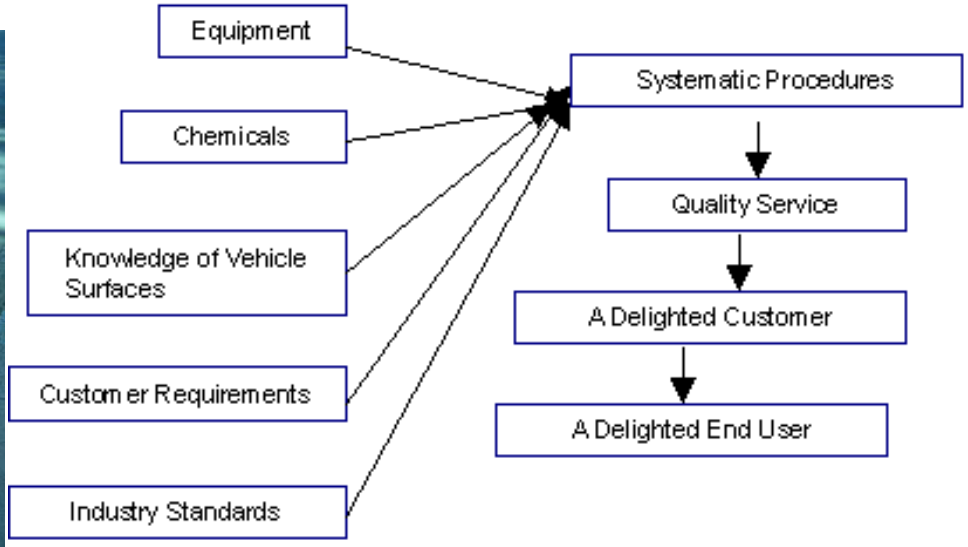
- “The definition of insanity is doing the same thing over and over and expecting different results.” - Einstein
- “Insanity in individuals is something rare - but in groups, parties, nations and epochs, it is the rule.” - Nietzsche

The Problem Statement

- Clean every surface of every chemical and biological warfare agent and toxic industrial chemical in every conceivable environmental condition without any damage to that surface
- After 100 years, the best option remains Hot Soapy Water
- Agent burden at a ‘mythical’ 10 g/m^2, but this doesn’t accurately reflect actual conditions



"Universal Decon" vs. Auto Detailing



- Automotive Car Care products are a multi-$B/yr market
- No single "universal" detailing product accepted by professional detailers or the consumer
- Products target specific material surfaces and types of contaminants
- Auto "detailing" still requires toothbrushes, Q-tips™, and 'elbow grease'

Materials

- Some materials and equipment configurations may not be reasonable to decontaminate (e.g. silicone, polycarbonate, RAM, rubber tires…)
- Alternative strategies to mitigate the associated hazards are required (do we even need to?)

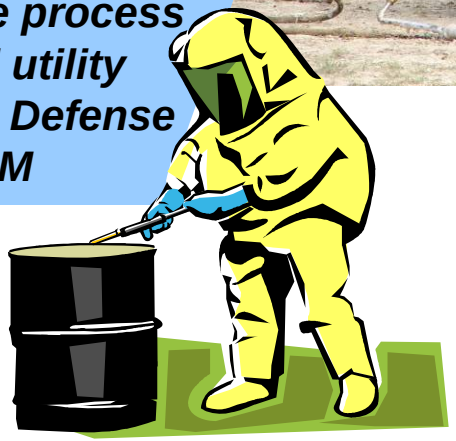
Everything Must be Cleaned!

- Some materials may be a “Combat Loss” after agent exposure – need to be realistic regarding what should be processed / not everything coming home
- Everything seems “Low-Density, High-Demand” on a battlefield

Rethinking Decontamination

THREAT
Terrorist or Nation State?

All-hazards approach
vs. "Universal Decon"
Scaling the process
Tactical utility
Homeland Defense
ORM



Agent burden
Substrate degradation
Decontaminatability
Hazard extent

Test methods
Toxicology
Standards
Process Validation
Remediation
Operations Research

Return on Investment?

Requirements Realism

- Yesterday:
- WWII Willy's Jeep (1943)
- Length = 132", Width = 62"
- ~54hp "Go-Devil" mogas engine
- "All Terrain" 4x4
- Mounts for automatic weapons, recoiless rifles, rocket launchers

- Today:
- John Deere M-Gator
- Length = 108", Width = 60"
- 18hp diesel engine
- "All Terrain" 6x4, but less ground clearance and hill-climbing capability
- Mounts for automatic weapons

The Battlefield Environment

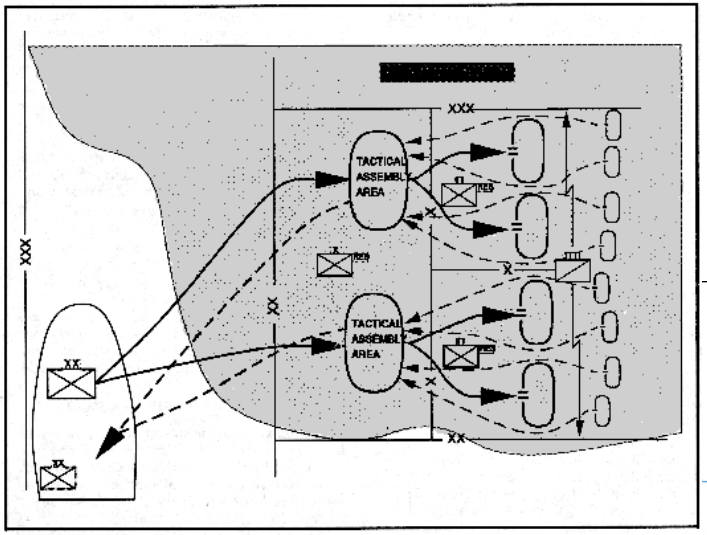
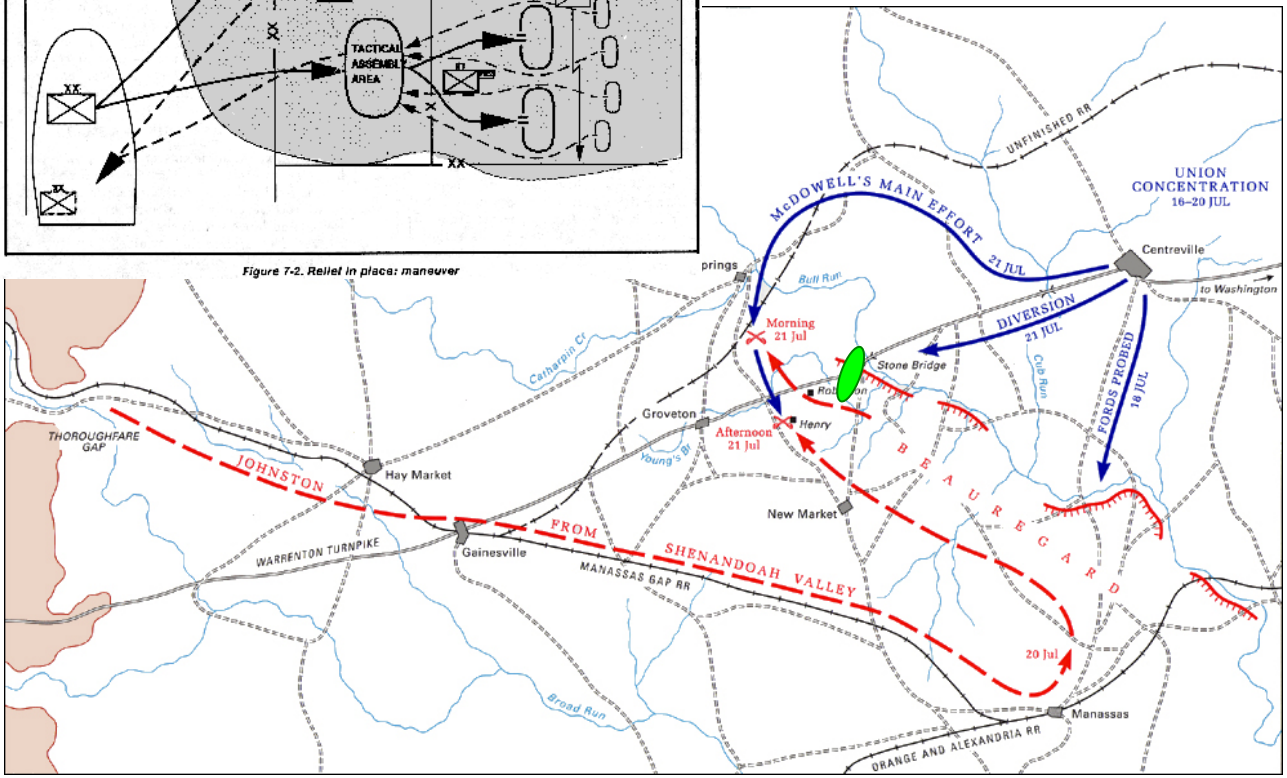


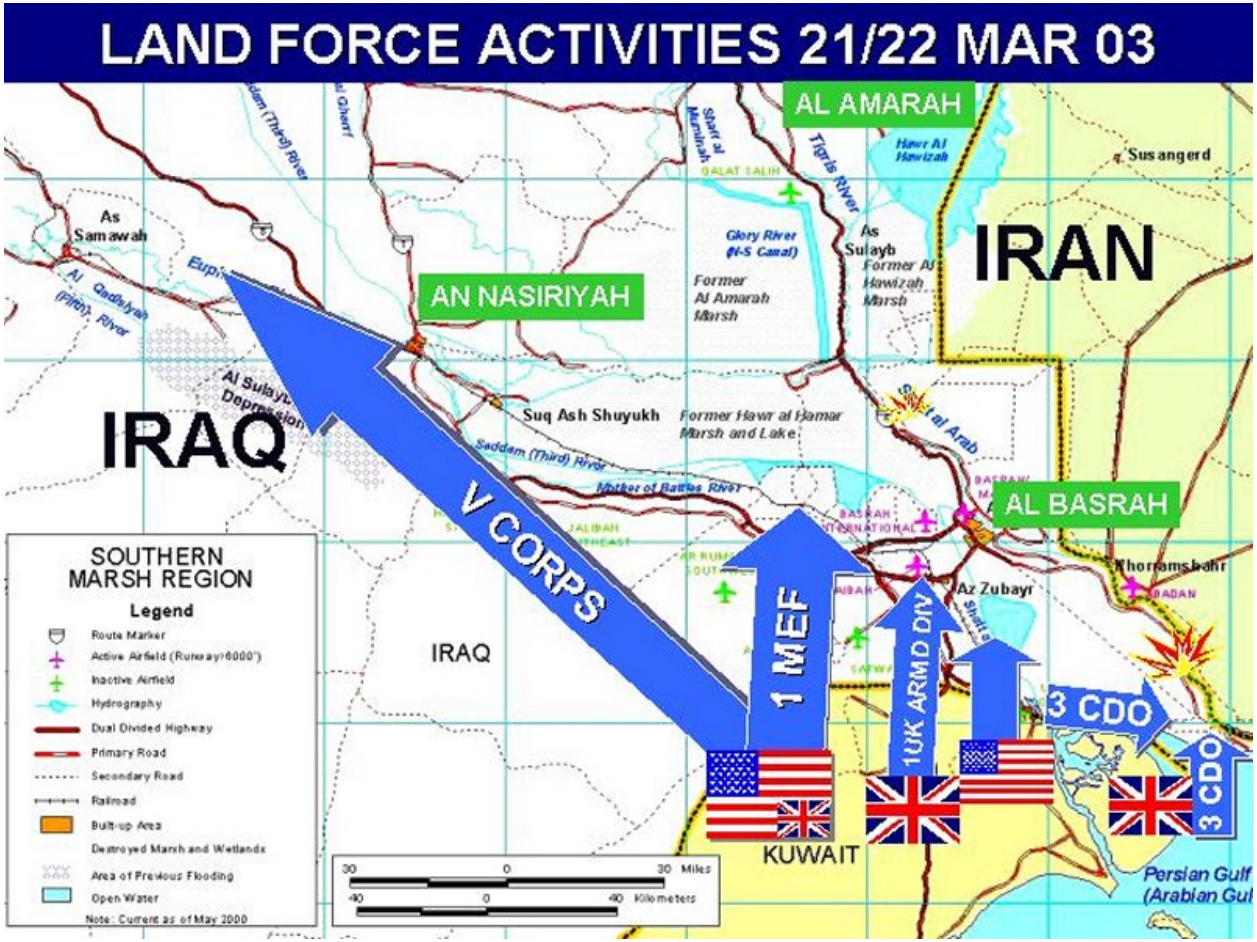
Figure 7-2. Relief in place: maneuver



- 1 metric ton VX @ 10 g/m^2 = 0.1 km^2 assuming perfect, no loss dissemination – but that is not reality!
- How will targets be serviced with CWA? Units rotated for decon?
- Location selection for decon may be extremely limited

Battlefield Environment, Cont

- Today's battlefield may cover hundreds of miles
- Logistical support of heavy decon may be difficult to impossible
- It may not be possible to pull units for decon for days at a time



Mud, Crud, & Blood

- Should be assumed as a standard condition
- Consists of anything and everything in the battlefield environment
- POL and even rotting food items!

The Decon Workforce

- Troops in MOPP IV for extended periods
- Few dedicated troops for decon operations, insufficient for large formations
- When performing “wet” decon, must wear raingear over MOPP to prevent penetration of agent

Taking the "man out of the loop"

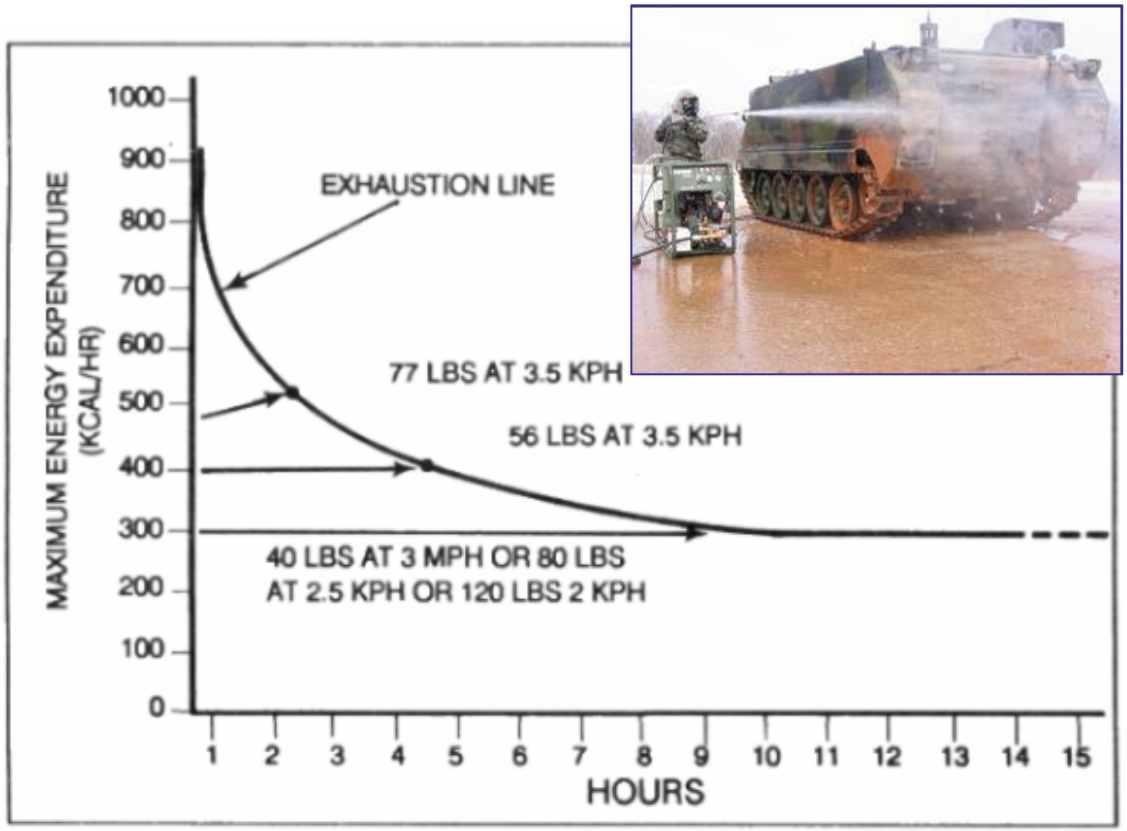
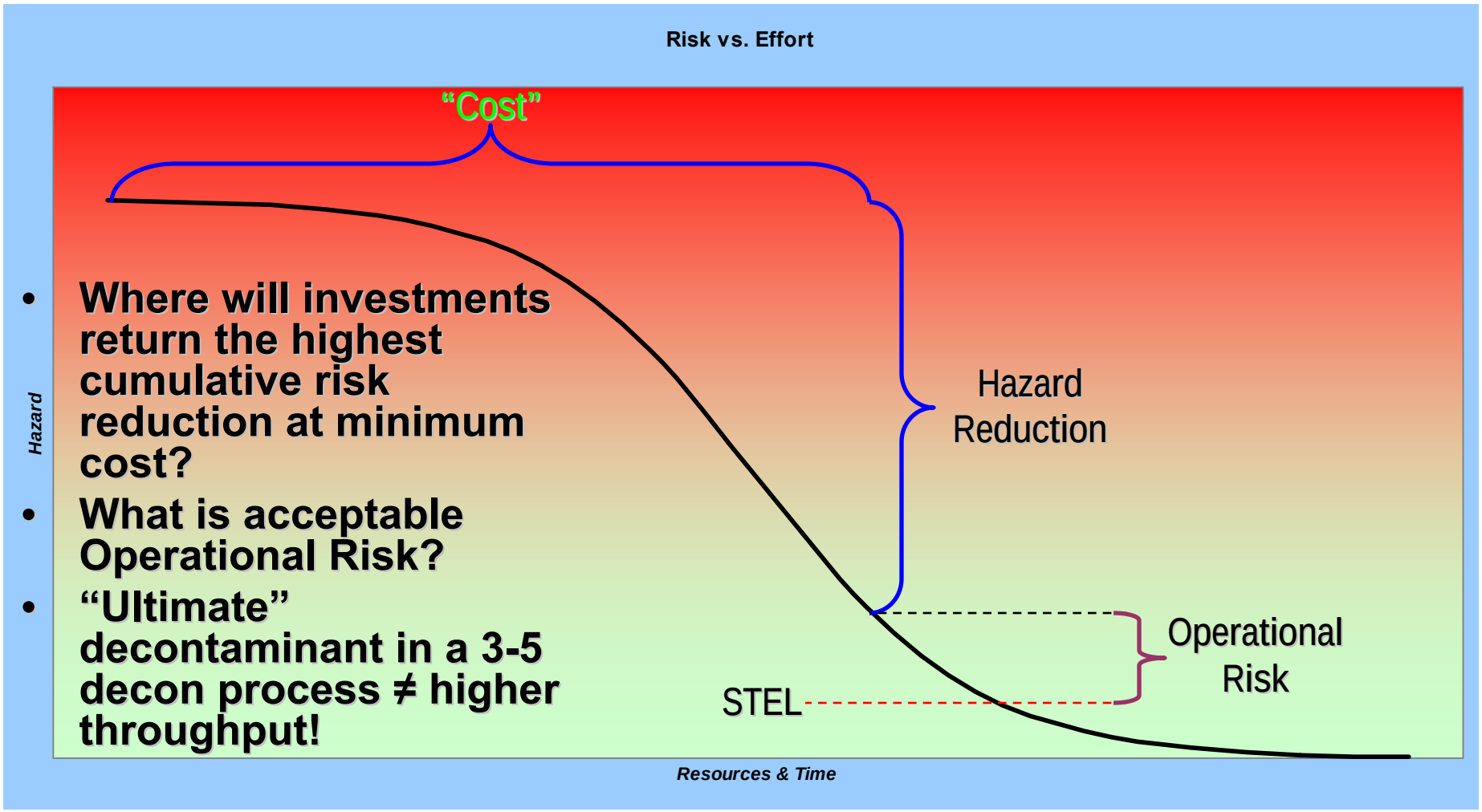


Figure 5-1. Work rate and energy expenditure.

- "Wet" decon process extremely labor-intensive
- Imperative to reduce manual effort required to achieve high throughput

Return on Investment



- **Where will investments return the highest cumulative risk reduction at minimum cost?**
- **What is acceptable Operational Risk?**
- **"Ultimate" decontaminant in a 3-5 decon process ≠ higher throughput!**

HazMit Next Steps

- Conduct a mission area “Rock Drill” with the warfighter – Operations Research to develop better ‘problem statements’
- Active intelligent reagent delivery systems
- Energetically activated coating systems
- Highly functionalized reactive surfaces for coating systems
- Enhanced and Expanded Hazard Reduction Performance Measurement Methodologies for New Technologies

Hazard Mitigation Rock Drill

- Work in concert with the JRO to re-examine Decontamination and define “Hazard Levels” and “Hazard Reduction”
- **OBJECTIVES:**
  - Draft an integrated architecture for future doctrine and systems to provide Commander’s in the field with definitive results from the Hazard Reduction Mission
  - Provide a vector for future S&T

What if?

- Reduce “levels of decontamination” from four to two (individual actions and theater-level)?
- Incorporate industrial-scale solutions for industrial-scale problems?
- Select mitigation methods and requirements based upon materials as used in systems?
- Adopt a dose-based risk management concept?

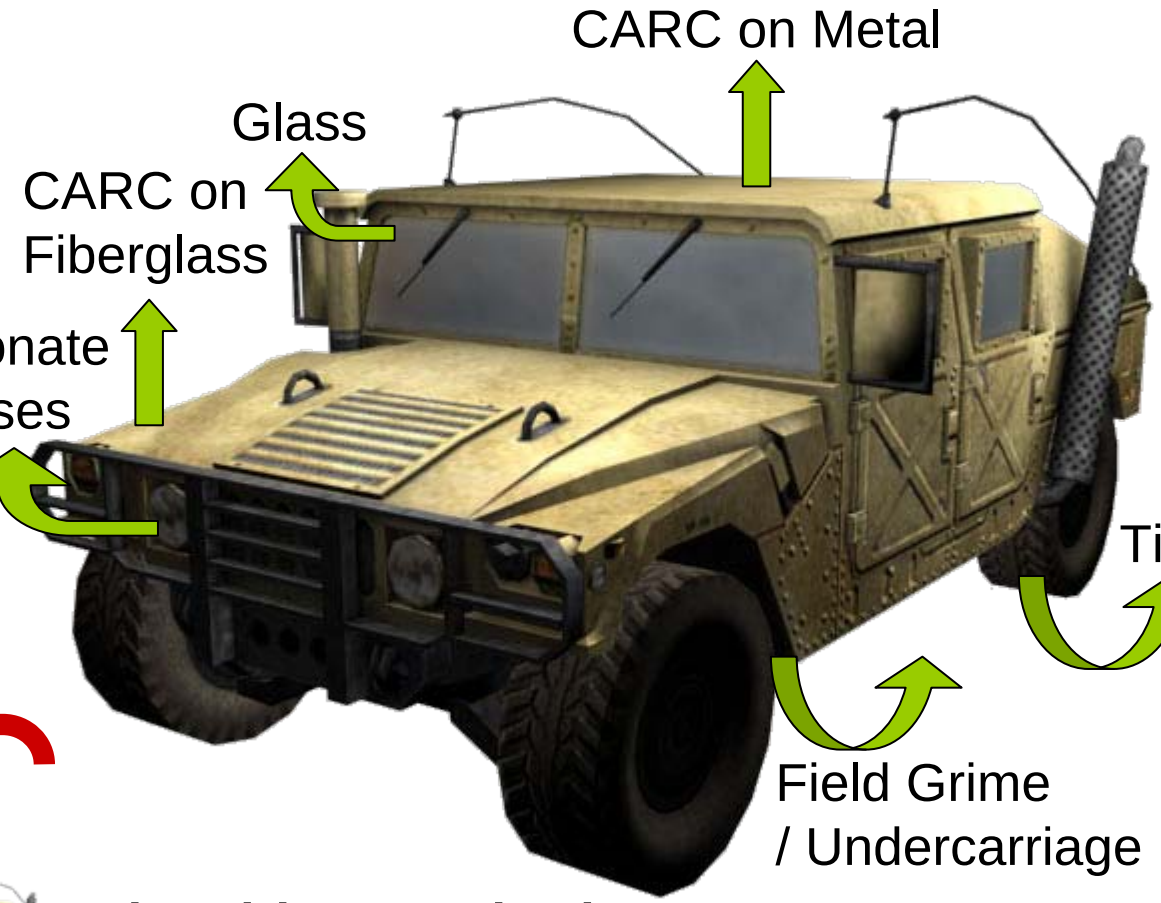
Levels of Decon

- Are the 4 current levels of decon realistically supportable? Which level generates the greatest impact on warfighting capability?
- Form of contamination & field grime not well described
- Many units likely to be contaminated may be least likely to receive detailed decon
- “Clearance Decon” may be described as “remediation”; a post-conflict mission

Process Scaling

- Industrial-scale processes for industrial-scale challenges, throughput measured in rolling tonnage, technical approaches must scale up well
- Large armored vehicles > 100 m^2 surface area @ 10 g/m^2 = 1 kg agent/vehicle
- > 50% of agent is removed during primary-wash step of standard FM 3-5 process, prior to decon application

Aggregate Source Terms



Exposure

- ***What drives total value?***
- ***Which parts need cleaning to reduce exposure?***
- ***Can we optimize on those specific materials?***

Dose-based Risk Management

- Already standard radiological TTP
- Can drive “how clean is clean enough?”
- Based upon typical mission profiles (e.g. 4 hour sortie, 6 hour transport via MTR, etc…)

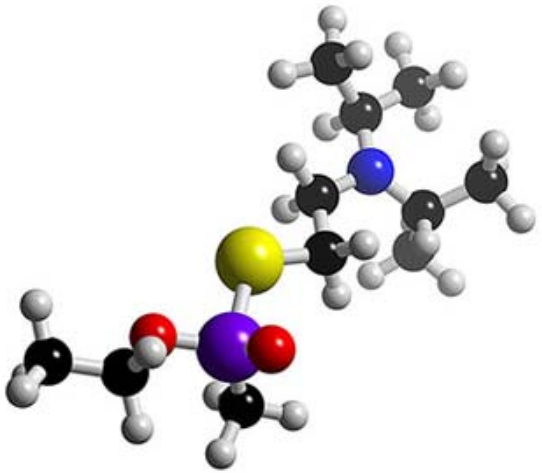
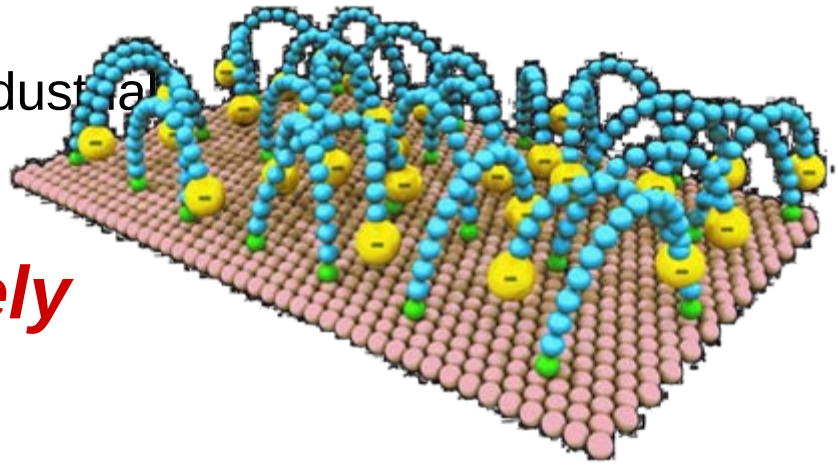


Table D-1. Operational Radiation Exposure Status and Risk Criteria

Radiation Exposure Status	Total Past Cumulative Dose in Centigray	Exposure Criteria for a Single Operation Which Will Not Result in Exceeding the Dose Criteria for the Stated Risk
RES-0 Units	This unit has not had radiation exposure.	Negligible risk, less than 75 cGy Moderate risk, less than 100 cGy Emergency risk, greater than 125 cGy
RES-1 Units	The unit has been exposed to more than 0 and less than or equal to 75 cGy of radiation.	Negligible risk, less than 35 cGy Moderate risk, less than 60 cGy Emergency risk, less than 85 cGy
RES-2 Units	The unit has been exposed to more than 75 and less than or equal to 125 cGy of radiation.	Further exposure exceeds negligible or moderate risk.
RES-3 Units	The unit has been exposed to more than 125 cGy of radiation.	Further exposure exceeds emergency risk.
Note: Nuclear RES guidelines specify units in cGy; however, the US Navy is required by the CFR to conduct radiation monitoring in classic radiation units, such as R, rad, or rem. 1 cGy = 1 rad.		

Hazard Mitigation Future Vision

- "System of systems" approach
  - Prophylaxis, pre-treatments, coatings (passive and/or active)
  - Warfighter with integrated capability – no need for specialized decontamination assets
  - Industrial-scale processes for industrial scale challenges when needed
- ***Process results must provide solid ROI, namely MOPP reduction***



System of Systems

Optical systems: high-tech solvent wipes

Gun barrel: no decon required

Exposed vehicle hull: reactive coating system

Road wheels & track pads: field grime and agent removal via automation & advanced surfactant system

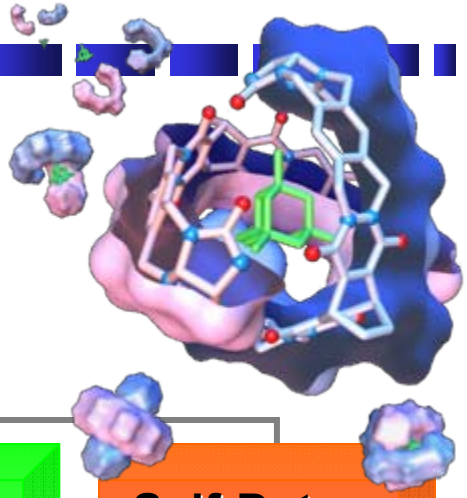
Hypothetical “system of systems” approach may incrementally reduce hazards:

1) **Reactive coatings on selected areas reduce majority of off-gas and contact hazards**
2) **Some areas of vehicle do not require decon in terms of aggregate hazard exposure**
3) **Larger “theater-level” systems may provide “polishing steps” for more complete hazard reduction**

Future Vision, Continued

- Revising concepts for hazard mitigation
  - Replace “decontamination levels” (e.g. Immediate, Operational, and Thorough) with outcome oriented “Hazard Levels”
  - Residual Hazard Levels should communicate IPE and operational risk clearly to the warfighter
- “Clearance Decon” may become a post-hostilities activity
  - Similar to Countermine (tactical mobility) vs. Humanitarian Demining (economic utility)
  - Environmental Remediation activity

New HazMit Taxonomy



Hazard Reduction Operations

Enabling Sciences

- Aerosol Science
- Standardization of Test Methods
- EPA Protocols
- Delivery method optimization
- Residual hazard analysis
- Reaction mechanics

Traditional Approaches

- Develop & demonstrate liquid and solid phase reactive systems for broad spectrum applications
- Optimize reactivity and materials compatibility

Energetic & Kinetic

- Develop & demonstrate processes using kinetic or energetic systems to reduce surface hazards
- Explore desorbtion methods

Smart Systems

- Develop & demonstrate systems that can *SENSE, RESPOND, and SIGNAL* response to threat agents
- Intelligent reagent release or threat capture

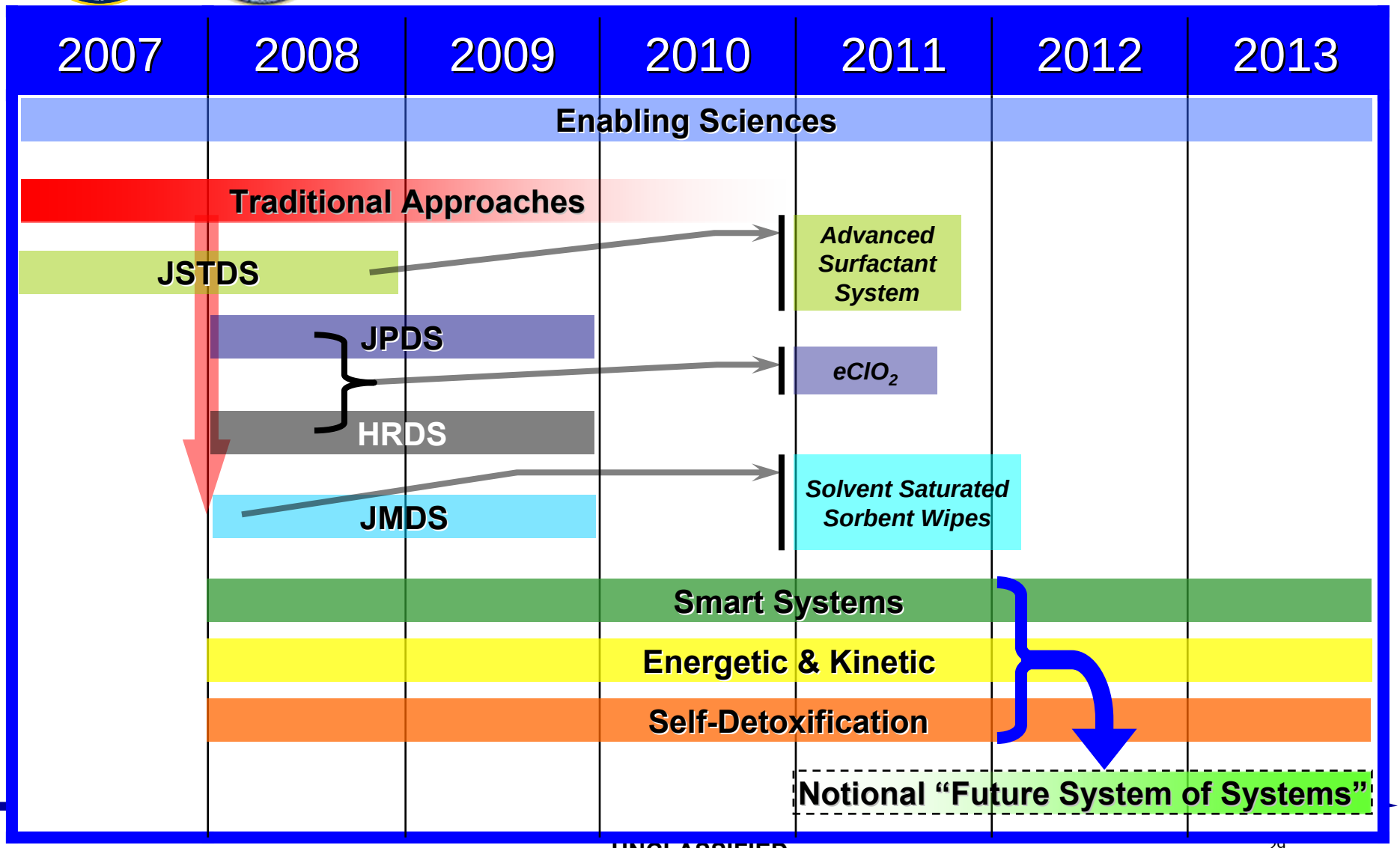
Self-Detox

- Develop & demonstrate reactive coating systems
- Durable or sacrificial
- Integration of reactive moieties that remain active through life of coating

Science Challenges

- Mass Transfer Limitations (interfacial & site density, droplet size & density)
- Analytics (***Enabling Sciences***)
- Catalyst Turnover
- Available Light Sources (photocatalysis)
- Coating Life and Survivability
- Signature
- Existing Coating System Requirements
- Selectivity
- Coating Matrix Effects
- Absorptivity vs. Non-Absorptivity
- Reaction Byproducts
- Humidity

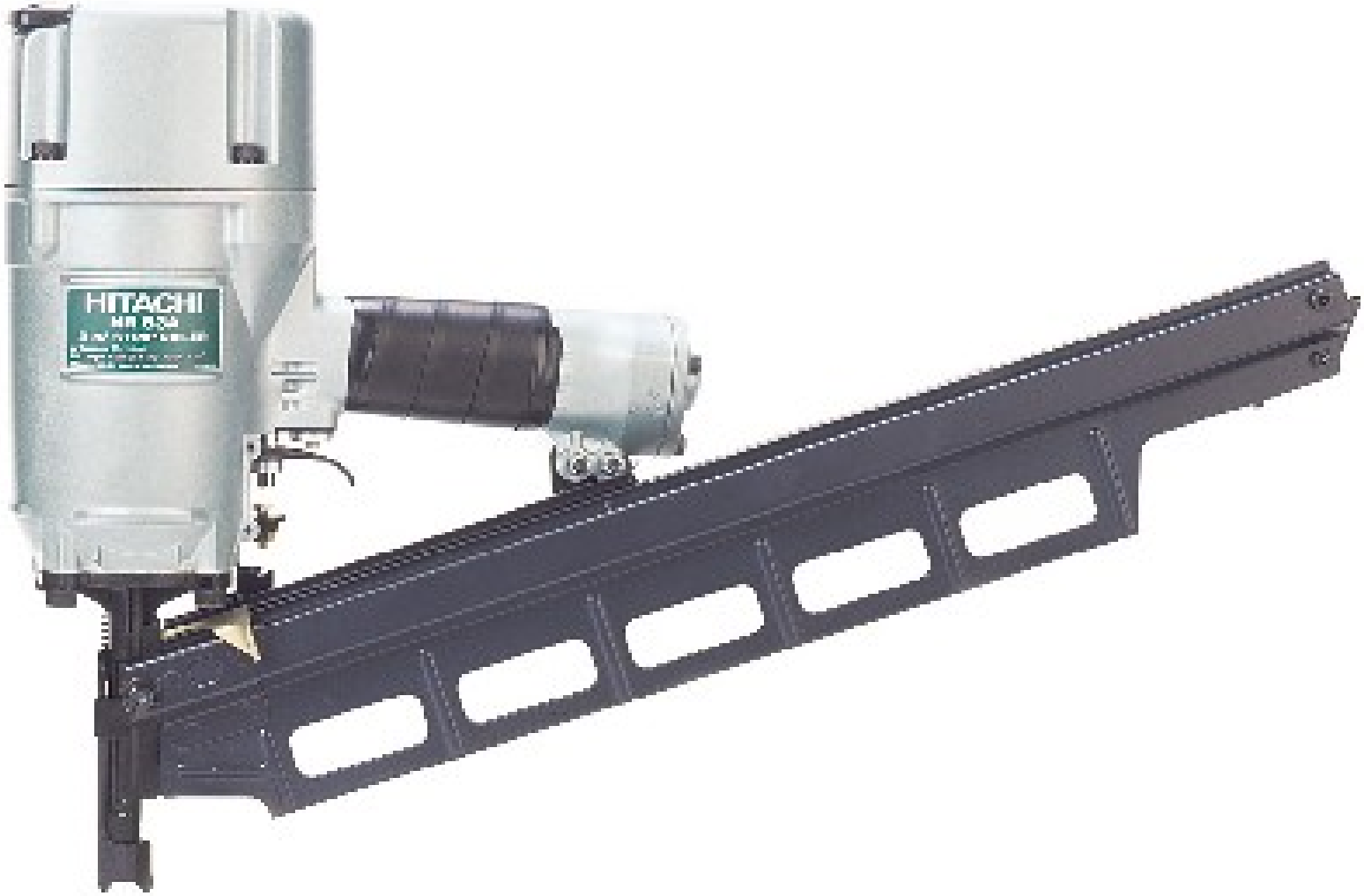
HazMit S&T Program Schedule



Summary

- JSTO realigned legacy Decontamination research into the Protection and Hazard Mitigation Area
- Tactical decon has not been well correlated with ***outcome*** (e.g. MOPP reduction)
- Future efforts will focus on “systems of systems” with improved ROI
- Still need to reconcile tactical military decon operations with Homeland Defense missions

With one of these:



You could build one of these:

But only if you have a clue…

- Just giving someone a tool doesn't make them a Craftsman!

QUESTIONS?