UK Hazard Management Research – Peelable Coatings

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Requirement

- When subjected to CBRN threats, force elements require the capability to quickly decontaminate themselves, equipment and areas of tactical significance, in order to survive attack and sustain operational tempo
  - DJtCap, Decon Strategy Paper

Aims

- Research programme seeks to better define the problem (and the capabilities needed to deal with it)
- Better understand the performance limits of passive and active control measures
- Identify and accelerate quick win solutions
- Work with “intelligent” suppliers to develop a system (of systems) incorporating fit for purpose decontaminants, equipments and processes

Technical Strategy

- **Overarching**
  - disclosure and verification

- **Enabling**
  - fundamental science

- **Reactive Formulations**
  - liquids, gases, aerosols
- **Tuneable Devices**
  - mixing, dispensing, stripping
- **Coatings**
  - absorbent, strippable, reactive

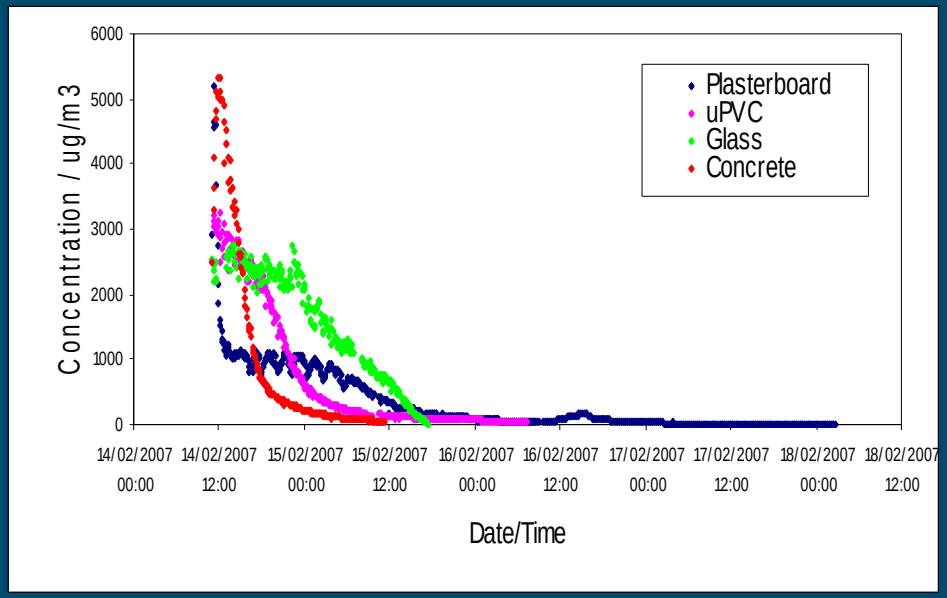
- **Capability Road Map**
  - personnel
  - platforms
  - sensitive equipment and aircraft
  - critical infrastructure and terrain

- **Underpinning**
  - OA, methods, process fundamental, Tech' Watch

  - Ground Manoeuvre
  - Home Office

Better problem definition – “what, where, when, how many?”

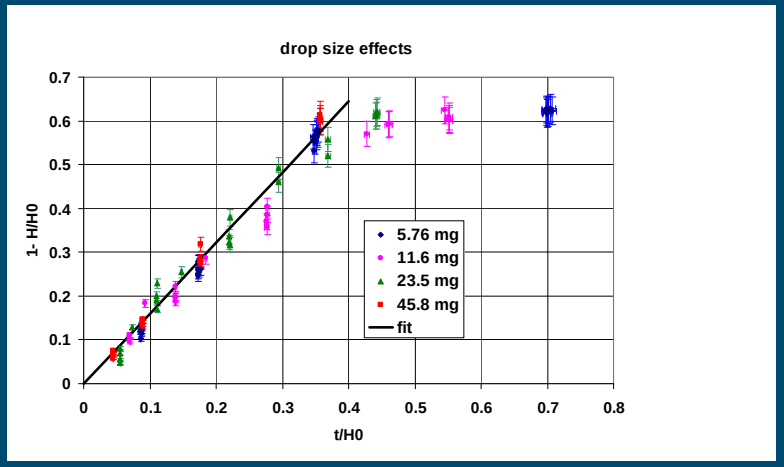
- Operational Analysis
  - Personnel Decontamination
  - Prioritisation Critical Assets
  - Threats and Vulnerabilities AFV (DEC GM)
  - Performance Criteria for New Camouflage Coatings
- Radiological Resuspension
- Fate of CW Agent on Building materials (Home Office)



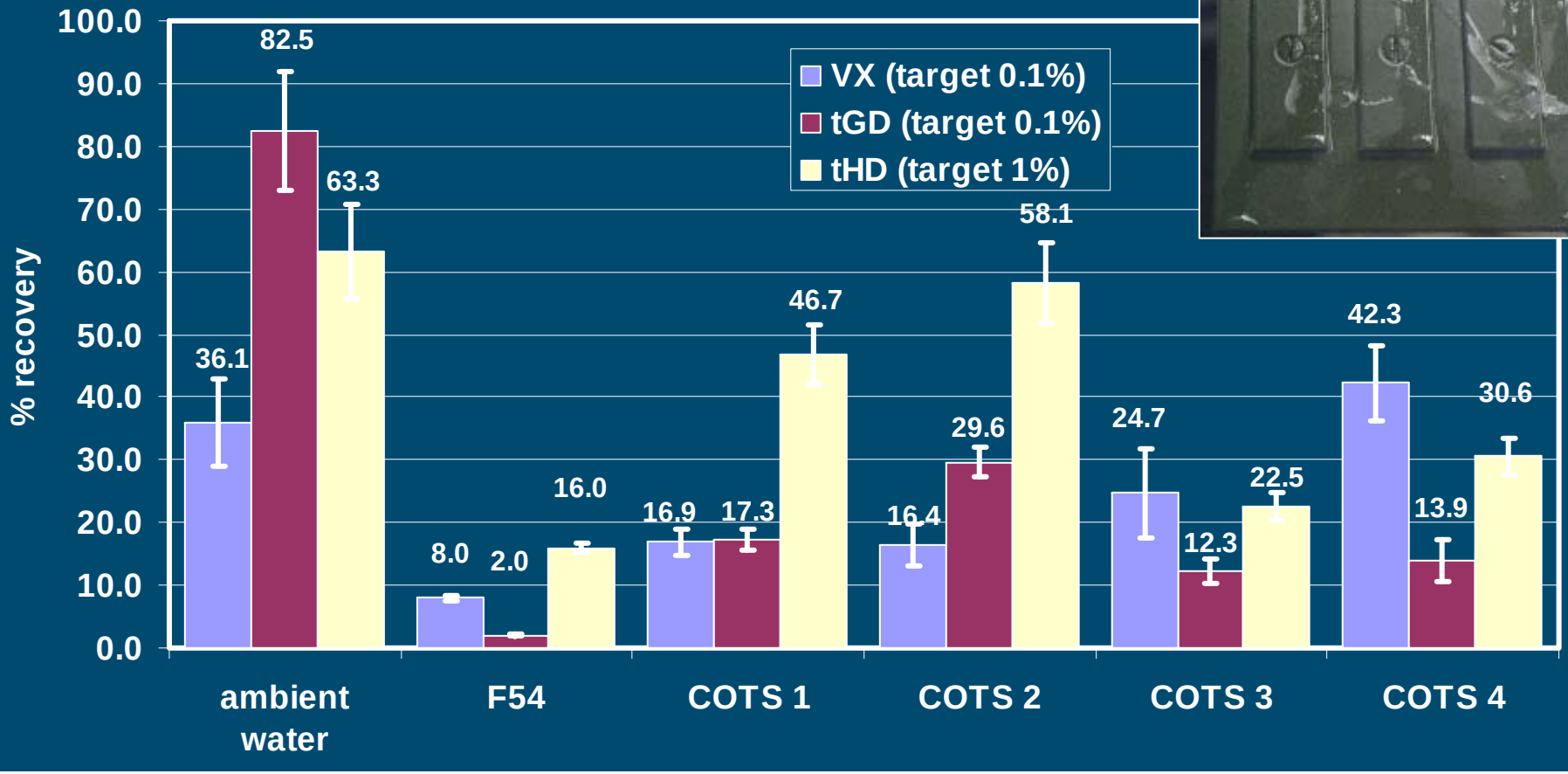
- evaporation of sulfur mustard from building materials - made during HO sponsored wind tunnel experiments

Understanding the performance limits of emerging technologies

- Process fundamentals
- Reactive gases (Home Office)
- Reliability assessment of optoelectronic devices
- Biotech approaches (enzymes and phage)
- Sonicated liquids
- Chlorine dioxide in microemulsions
- CW agent disclosure
- Peelable coatings

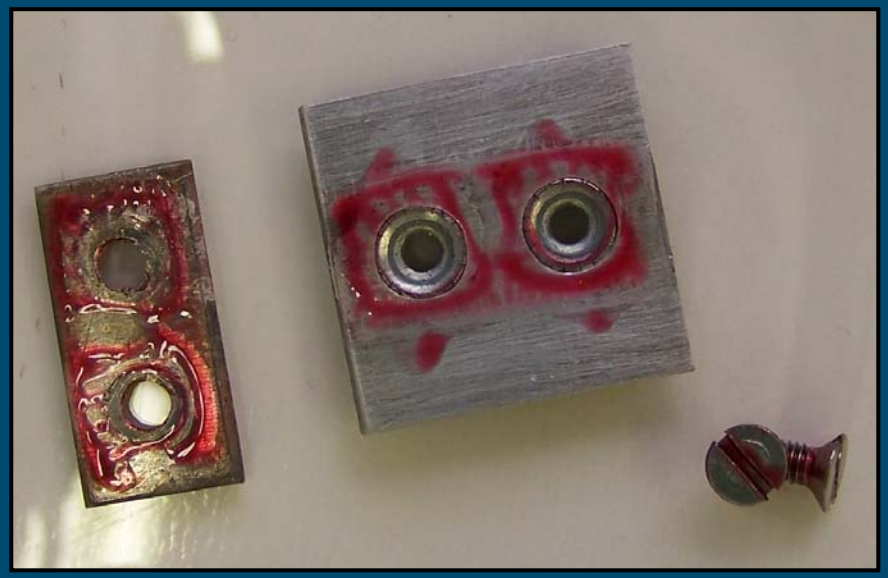


Performance limits – decon of complex surfaces



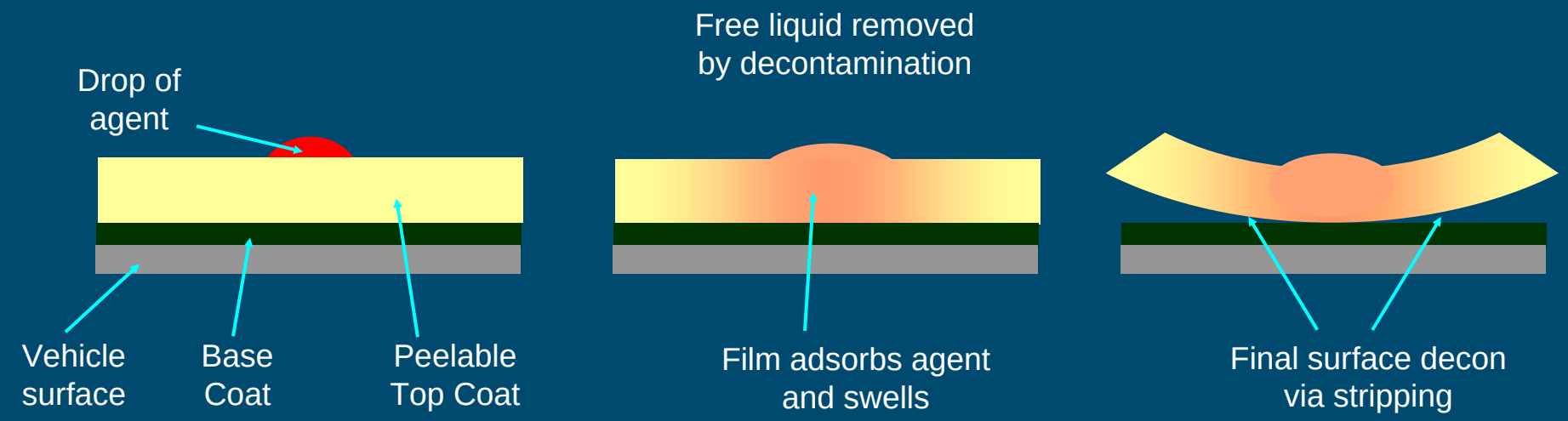
Entrapped agent

- No COTS decon system tested could accomplish required level of clean using current procedures
- COTS technology does not addresses problem of entrapped agent
- So where do we go from here?



Towards a solution – “Binary Decontamination”

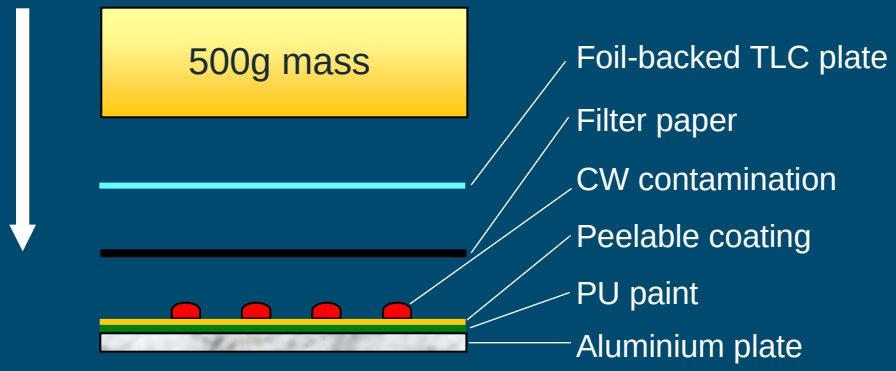
Passive absorbent coating - mode of action

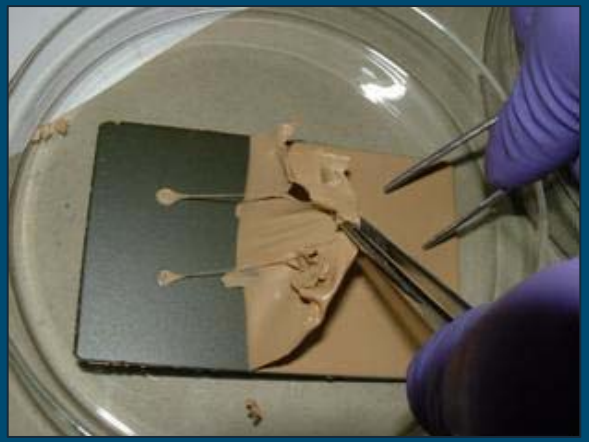


- Paint resin is swelled by the agent
- Liquid decontamination required to remove free-liquid contact hazard
- Agent is partially immobilised but not destroyed – diffuses slowly out
- Contaminated coating peeled and disposed of

Contact Test Method

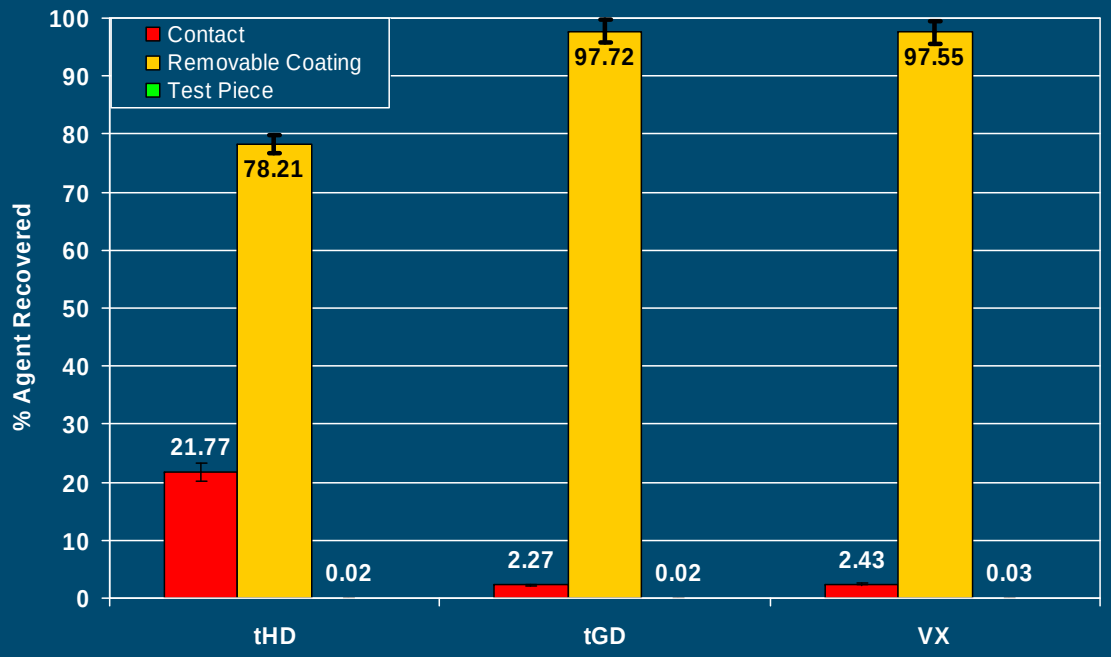
- Qualitative laboratory assessment
  - swelling
  - peelability
- Quantitative laboratory assessment
  - free liquid contact hazard
  - agent absorption into coating
  - agent break-through



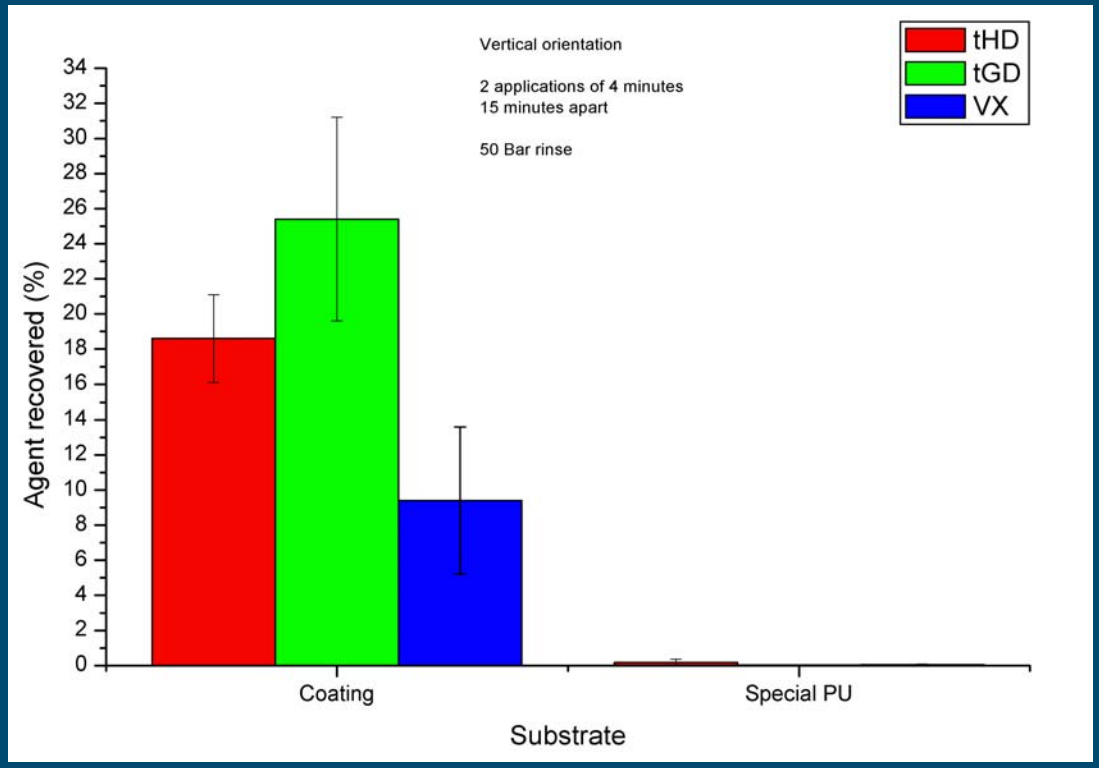


Absorbent peelable coatings

- Programme identified absorbent coatings that
  - readily absorbs liquid CW agents
  - reduced contact hazard
  - prevented contamination ingress into treated surfaces
  - aid Thorough decontamination when removed



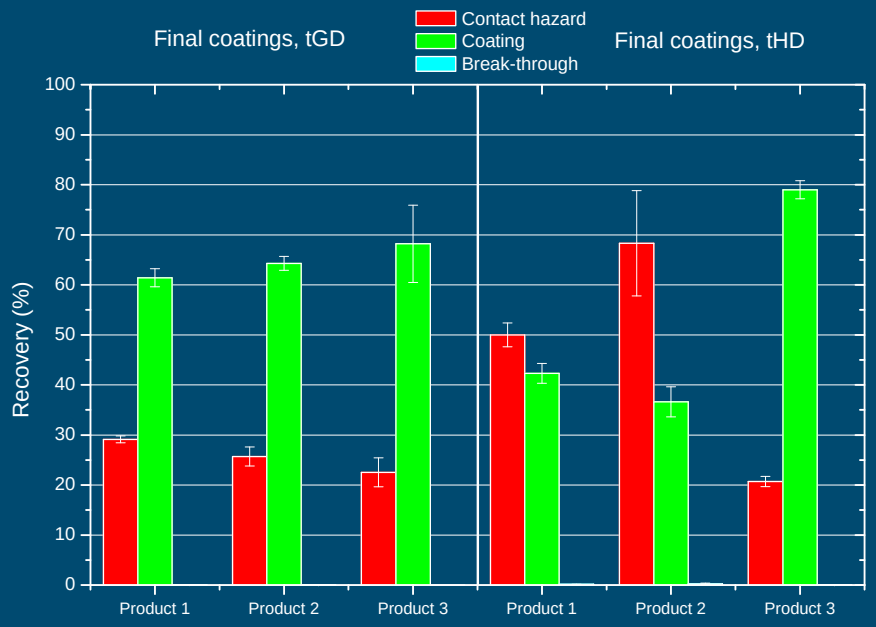
New F54 decon in combination with strippable coatings – CW agent chamber trial



- Only demonstration of Thorough decontamination on complex surfaces in whole system tests

Development of new camouflage coatings

- Three manufacturers engaged to optimise existing formulations
  - maximise absorbance
  - retain peelability and prevent break-through
- Set benchmark criteria for defence standard
- Extensive series of iterative test and reformulation conducted
  - over 30 prototypes coatings and 450 live agent lab experiments



CVRT vehicle – simulant field trial

- Aim to assess Binary decontamination process
  - compare and contrast each manufactures coating in product side-by-side on combat vehicles
  - relate contact-test performance to whole-vehicle performance
  - determine coating thickness affects
  - simulated “in-theatre” re-application
  - optimise process

Coating application

- Applied using Kremlin AirMax air-assisted airless system
  - 200 µm DFT target

Contamination

- Tributylphosphate (TBP)
  - G-agent
- Thickened methyl salicylate (tMS)
  - Thickened sulfur mustard

Decontamination

- Spray-then-brush regime
  - Two-man team.
  - 20 L (two fills) per side

- BX 24 decontaminant applied using vehicle-borne decon system (VBDS)
  - In-service vehicle operational decon equipment

Manual stripping

High pressure water stripping

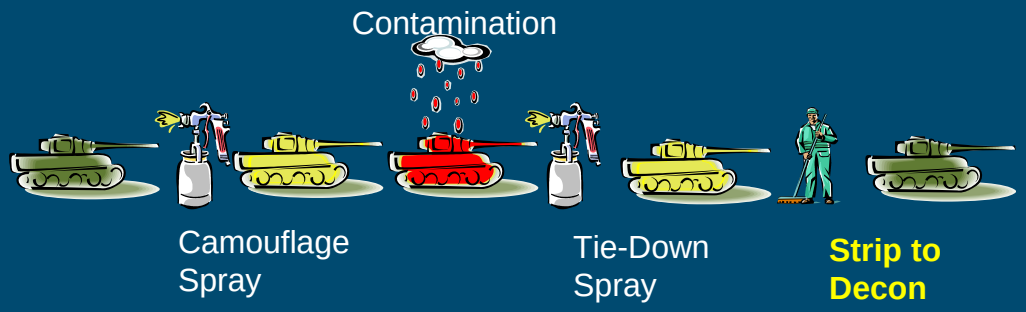
Chemical agent tie-down

- Surface coated to ~200 µm DFT
- Contaminated with tMS and TBP
- 1 hour dwell
- Re-sprayed with coating (no decon)

- Cured over TBP and lightly contaminated tMS
- Failed to cure over gross tMS contamination
- Off-gassing detected
- Stripped successfully

Radiological tie-down

- Application of the tie-down coating on top of an existing camouflage coating
  - Reduced re-suspension hazard
  - Sandwiched contamination removed when stripped



Initial contamination (1 GBq/m²)	Maximum Stay Times	
	Alpha	Beta
Unprotected	3 minutes	39 hours
After Tie-down	22 hours	50 hours
After Stripping	225 hours	> 1 year

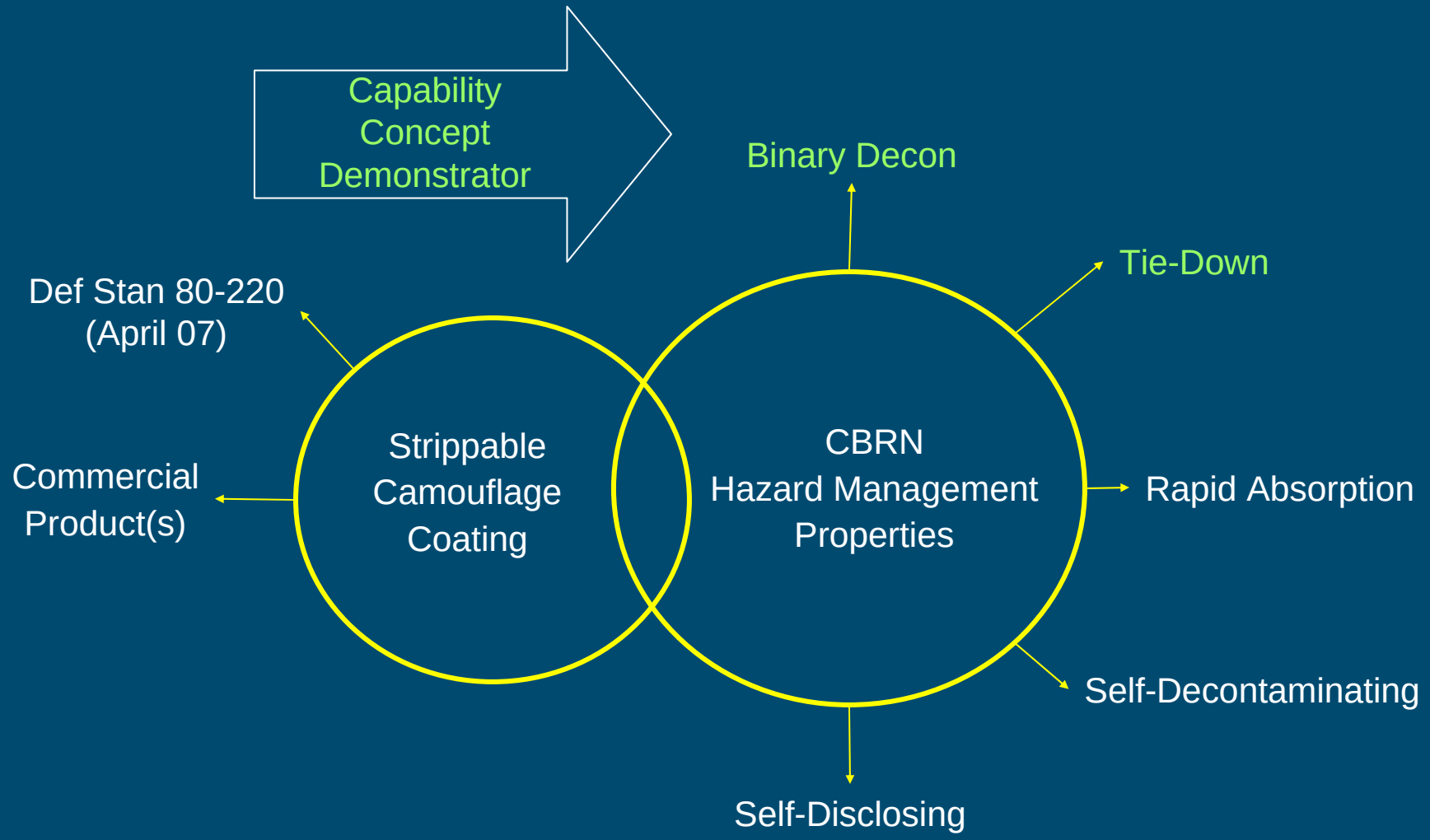
Vehicle trial - conclusions

- Laboratory contact test reasonable indication of whole-vehicle performance
  - qualitative observation of contaminated coating on vehicle as expected from contact-test
  - all three final formulations maintained integrity and could be peeled.
- Decontamination had little detrimental effect on the coatings
  - removed majority of free-liquid without damage
- Optimised stripping regime
  - manual peeling followed by HP water blasting
- 2-300 µm optimum film thickness
- In-theatre reapplication feasible
  - chemical tie-down feasible
- Identified best performing coating
  - best balance of adhesion / cohesion

New coating deployed in-theatre

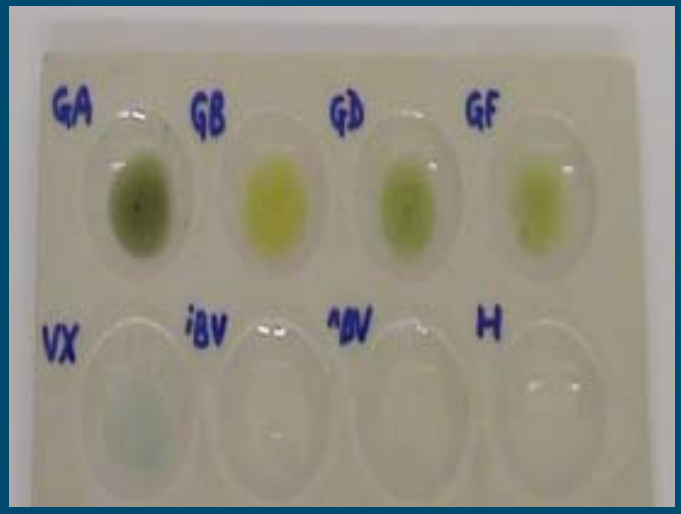
- New coating procured to Def Stan 80-220
- Op. HERRICK
  - 90 Warriors deployed (June 07)
  - 120 Assorted vehicles (August 07)
- Incorporating solar heat-reflecting pigment

Coatings Technology Road Map



CW Agent Disclosure Coatings

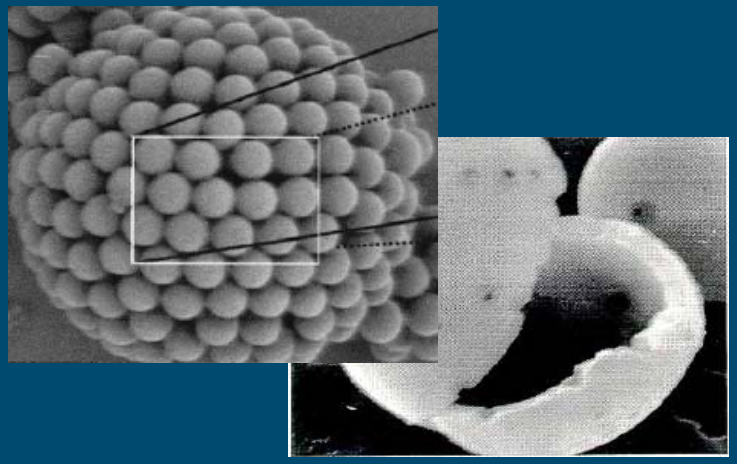
- A simple spray system has been shown to be effective at disclosing low volatility nerve agent
  - produces colorimetric and fluorescent response to nerve agents
- Microporous polymer containing functional moieties also fluoresce in the presence of nerve agent
  - potential use in coatings
- Needed to optimise the response to nerve agents and determine quantitative detection limits (post decon)



Core/Shell particles

- Widely used where controlled release of liquid needed (e.g. in vivo drug release)
  - the cores can be oil or water
  - the shells can be inorganic or polymeric
  - the release rate profile may be varied by careful control of the nature of the shell and the form /concentration of the active ingredient
  - release may be solely time-dependent, or triggered by chemical disruption of shell

- Assess the feasibility of CW agent-triggered release of core contents
  - self-decontaminating coatings
  - self-disclosing coatings



In summary

- Outputs from basic science and OA being used to better define concepts of use for new capability areas
- Assessments of several emerging technologies have been screened against developing requirements
- Industrial suppliers being engaged to deliver required capabilities
- Quick win solutions using strippable camouflage coatings being fielded