US AIR FORCE AIRCRAFT DECONTAMINATION DEMONSTRATIONS

EPA International Decontamination Conference
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Two Key Programs

Joint Biological Agent Decon System

Joint Strike Fighter

Live Fire Test

JBADS versus JSF

JBADS

- Objective: Develop a decontamination system for large frame aircraft
- Emphasis on the system design
  - Efficacy
  - Compatibility
  - Transportability
  - Logistics

JSF

- Objective: Verify aircraft design requirements for CB decontamination
  - First aircraft with quantitative requirements for chem & bio decon
- Emphasis on aircraft materials and test methods
- Decon system is needed for demonstration

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Prior Aircraft Decon Demonstrations

1998 – Cargo Aircraft Contamination Control (CACC) Field Test (AMC)

- Chemical decon by flight
- Effective for vapor exposures but not very effective for liquid exposures

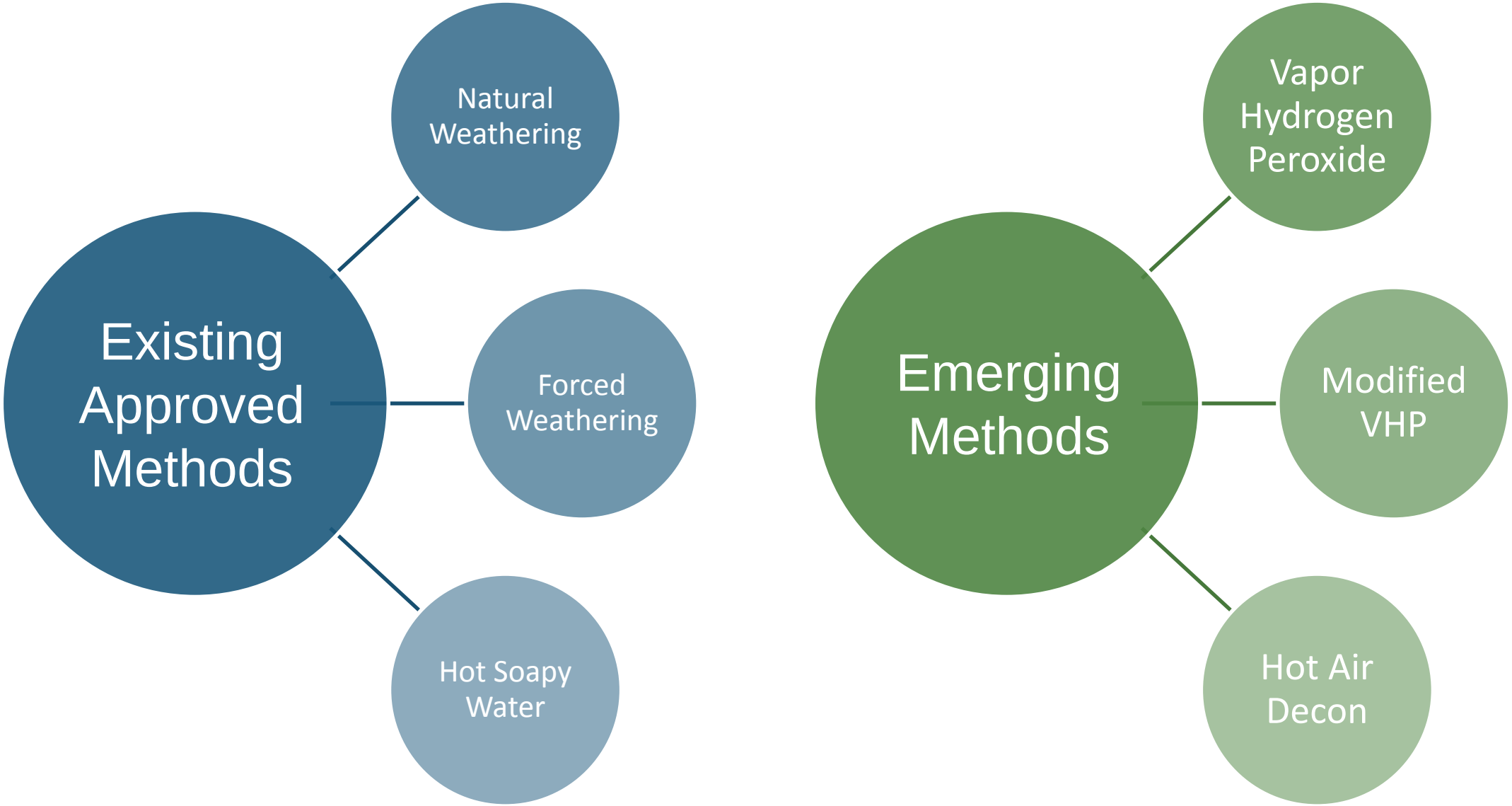
2001-2003 – Large Frame Aircraft Decontamination Demonstration (DTRA)

- Chemical decon by flight and Hot Soapy Water
- "Exploration of more effective, extractive decontamination procedures is recommended."

2003-2004 – Hot Air Decontamination of the C-141 Aircraft Technology Development Program (ECBC)

- Chemical decon by "Hot Air System"
- Effective but dependent on airflow and materials

JSF CB Decon Options



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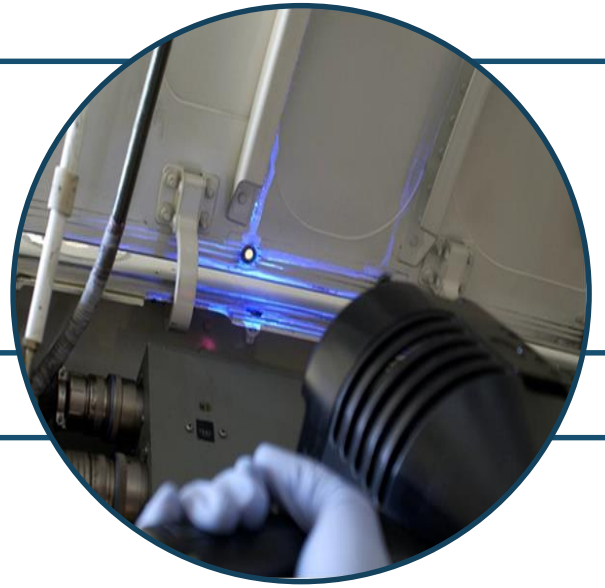
2005 JSF Risk Reduction Exercise (CB-08)

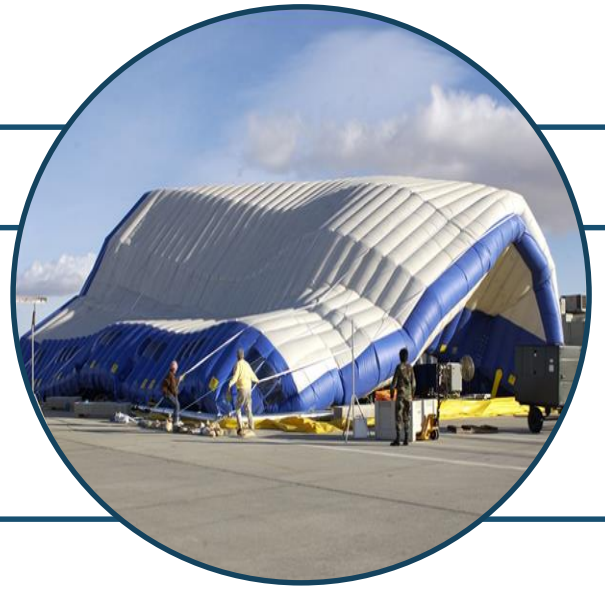
Hot Soapy Water

- Contamination forced inside
- Significant Effluent Generated
- High potential for cross-contamination



Hot Air Decon

- Difficult to maintain consistent temps
- Metal shelter could not be sealed



VHP

- Material compatibility concerns
- Inflatable shelter failed

CB-08 Path Forward

Hot Soapy Water

- Taken out of consideration

Hot Air Decon

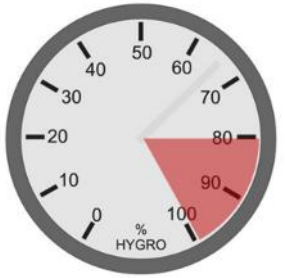
- JPM P set out to mature the technology

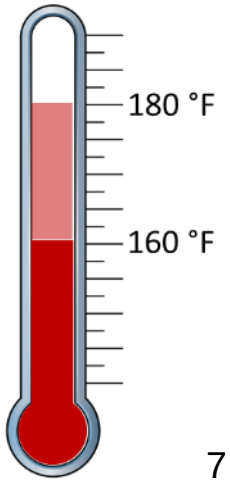
Vapor Hydrogen Peroxide

- AFRL/JSF funded additional materials compatibility studies for VHP
- AFRL looked for alternatives for bio decon

Origins of BioThermal Decontamination

- 2007 FAA study of “thermal decon” with VHP on a DC-9 aircraft
- 2007-2008 AFRL proof-of concept for hot/humid air as BWA decontaminant





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2008-2009 JBADS Demonstration

DC-9, Orlando, FL

- 5-6 log reduction of Btk within 48 hours in 3 trials:
  - 176 F & 87% RH
  - 168 F & 91% RH
  - 176 F & 90% RH
- No degradation of materials
- Difficult to maintain skin temps with variable ambient temps

2009-2011 DTRA Tier I Testing

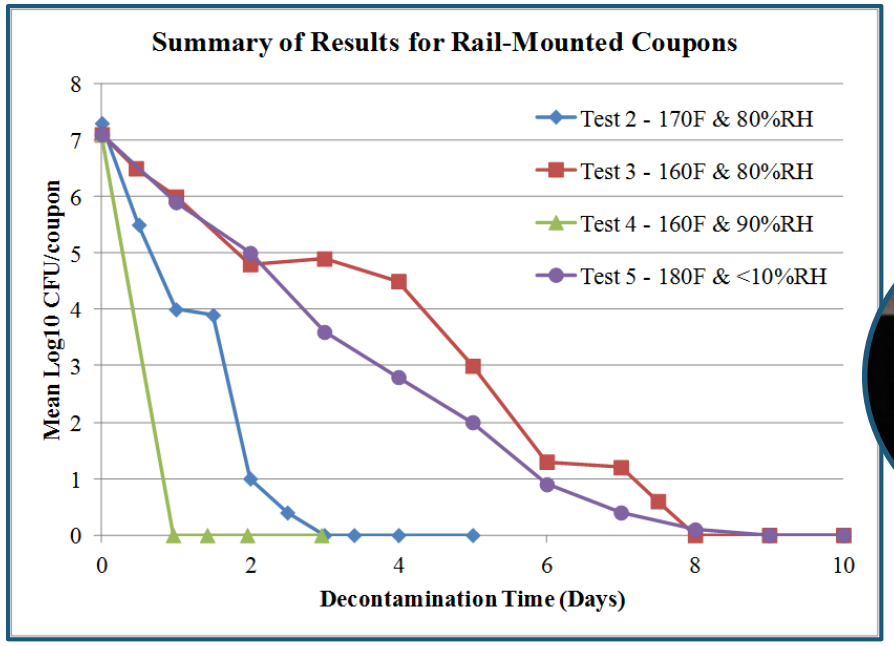
- Three government labs: AFRL–Brooks City, ECBC, NSWC-Dahlgren
- Confirmed efficacy and agent-simulant correlation for endospore-forming BWAs

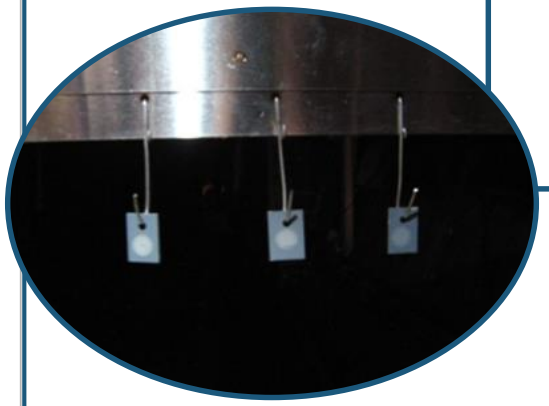

DC-9


Coupon Rails


Insulation

2011 JBADS Demonstration





C-130, Little Rock Air Force Base

- 6-log reduction of Btk in 4 trials:
  - 170 F & 80% RH
  - 160 F & 80% RH
  - 160 F & 90% RH
  - 180 F & <10% RH
- Minimal material impact – not a flyable asset
- Skin temperatures ~15 F cooler than air, despite insulation and summer temps
  - Skin-mounted coupons not decontaminated at the same rate

Build an insulated enclosure for simultaneous interior and exterior decontamination

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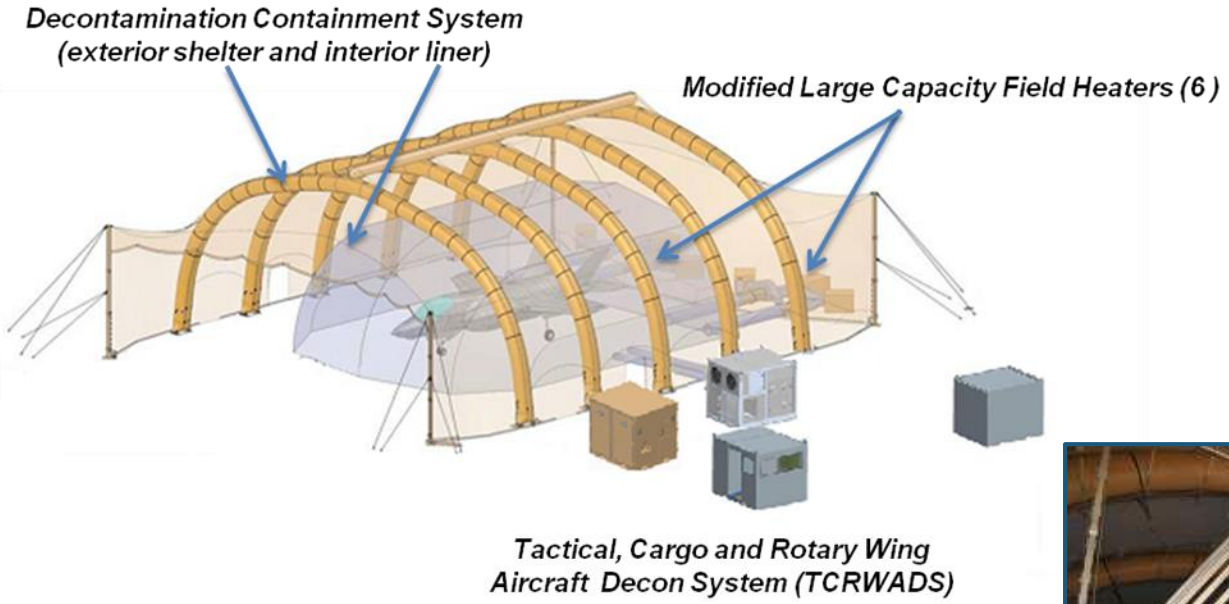
2012-2014 JSF Shelter/Decon Demos




Sept 2013 – St. Louis, MO

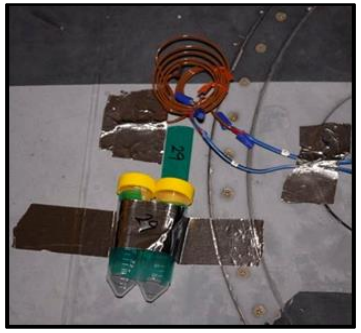

Jan 2012 – Lake Elsinore, CA

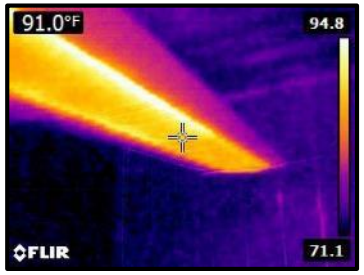

Sept 2013 – St. Louis, MO

JPM P Decon System Design

- Make use of existing equipment:
  - Ames airbeam shelter
  - Large Capacity Field Heaters
  - TCRWADS – an adaptation of the Environmentally-Friendly Aircraft Decontamination System (EFADS)
- Create sealed, closed-loop environment – insulated liner system (R2/4)
- No simulant efficacy testing in these demos

2014-2015 JBADS JCTD





C-130, Orlando, FL

- Joint Capability Technology Demonstration (JCTD)
- Conformal Aircraft Enclosure
  - Structural Insulated Panels (R32)
  - Not vapor tight but sufficient for bio decon
- Two Operational Demonstrations – BTD at 170 F & 90% RH with inoculated coupons
  - OD#1 – 5.9-log reduction of Btk in 72 hours
  - OD#2 – 7.0-log reduction of Btk in 96 hours
- Aerosol Test (DTRA/NSWC-DD)
  - Bt HD-1 cry- aerosol released in cargo bay
  - Swabs and coupons used to confirm >6-log reduction within 7 days at 170 F & 90% RH

2014-2016 JSF Shelter/Decon Demos

2014 – Edwards AFB
- Blanketed-liner system
- HAD was sufficient
- BTD humidity could not be maintained
- Excessive condensation

2016 – St Louis, MO
- SIP-liner system
- HAD was sufficient
- BTD humidity could not be maintained
- Excessive condensation

2016 – HAD effective against BWA (JSF/NSWC-DD)
Decision to use HAD for both chem and bio decon

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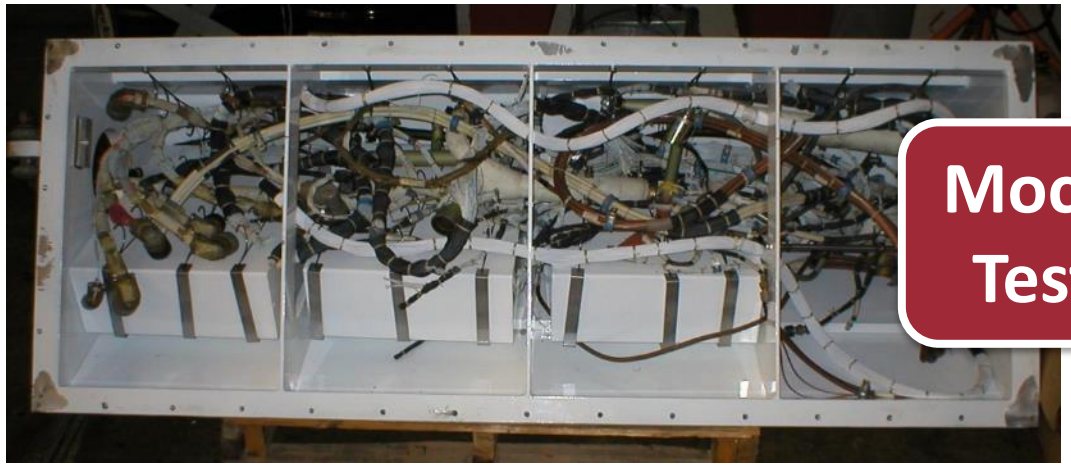
Build-up to JSF LFT – Beyond the Decon System

F-16 Demo

Mock-up Testing



Materials Compatibility

Agent/Material Agent/Simulant

Airflow Testing

Simulants

MeS

Methyl Salicylate

- Oil of Wintergreen
- Food Additive
- Used as a CWA simulant for many years
- No EPA or OSHA limits

Btk

Bacillus thuringiensis variety Kurstaki

- Readily available organic insecticide
- Correlation to BWA established
- No EPA or OSHA limits

Challenge Delivery

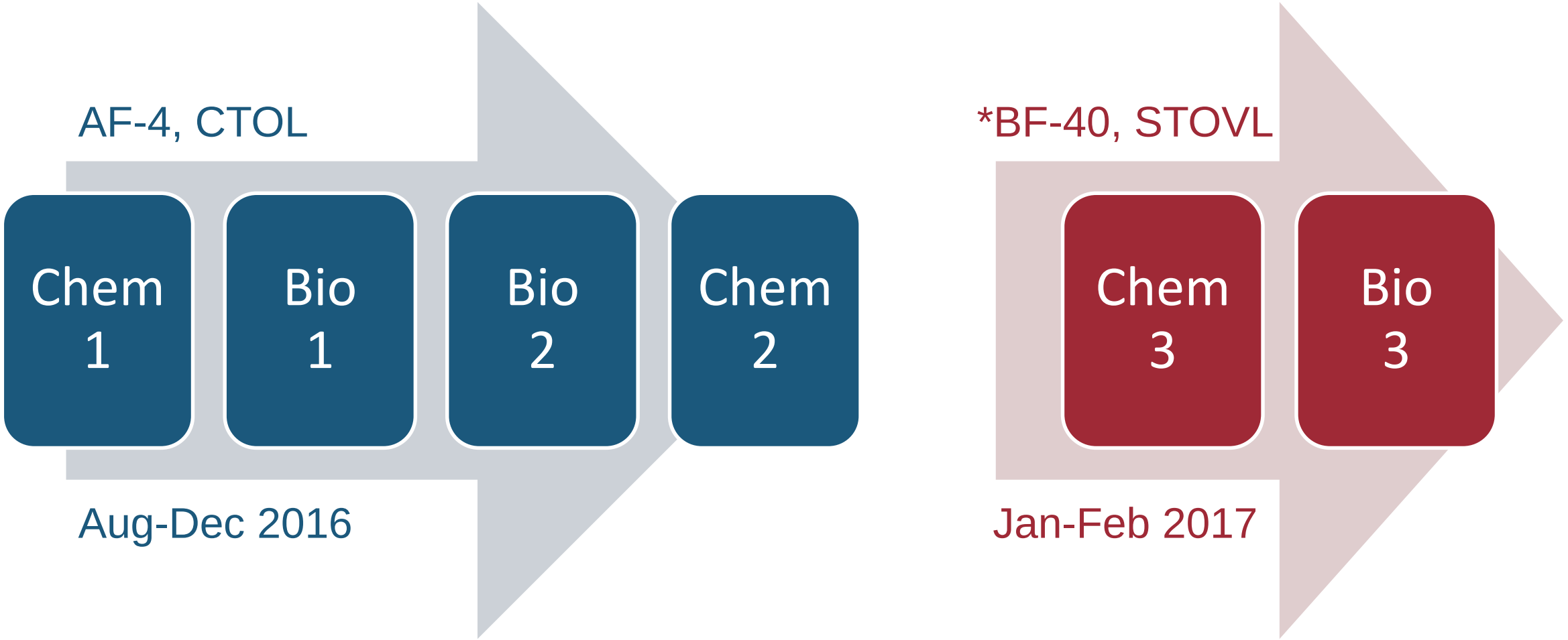
Simulant diluted with water to increase spray volume.
Water evaporates quickly from small droplets in high air flow, leaving “dry” simulant in air stream.

2016 JSF LFT Decon Enclosure

Process Monitoring

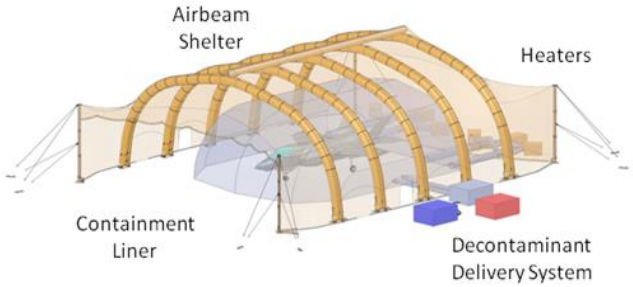
METSS applied ~50 thermocouples and 3 humidity sensors prior to decon

Testing Sequence



*Functional Check Flights upon receipt and return

CB Tests (Top Level)



Simulant Ingestion

- Simulant sprayed directly into the engine inlets while engine at idle
- Aircraft relocated and run at MIL power for 2 minutes; additional Lift Fan Vibe BIT for STOVL

Decontamination

- Aircraft towed into the decon enclosure
- Heated to 170-180 °F (same for chem and bio)

Post-Decon Engine Run

- Aircraft towed to a clean area
- High-Speed, Low-Thrust engine run at idle to see what “shakes loose”

Sampling before during and after each phase of testing

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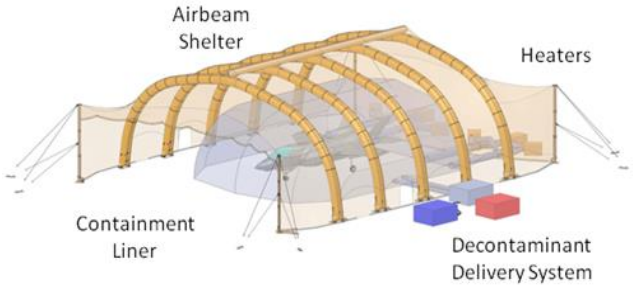
Representative CHEM Results



Before Contamination	After Engine Ingestion	After Liquid Deposition	DECONTAMINATION	Immediately After Decon	Before Engine Run	After Engine Run
• No simulant detected • Clean baseline	• No simulant detected!!	• High vapor levels throughout aircraft inside enclosure (max 733 Ct)		• Trace amounts remain on aircraft inside enclosure (max 0.09 Ct) • PASS	• Trace amounts diminish slightly outside (max 0.02 Ct)	• Trace amounts diminish further (max 0.01 Ct)

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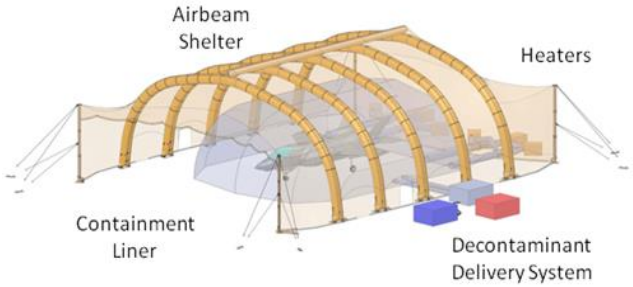
Representative BIO Results



Before Contamination	After Engine Ingestion	Before Decon	DECONTAMINATION	Immediately After Decon	Before Engine Run	After Engine Run
• No simulant detected • Clean baseline	• 6-7 $\log_{10}/m^2$ in air inlets • 0-4 $\log_{10}/m^2$ throughout	• 6-7 $\log_{10}/m^2$ in air inlets • 0-4 $\log_{10}/m^2$ throughout		• **NO viable simulant spores** • PASS	• **NO viable simulant spores**	• **NO viable simulant spores**

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Current Status

JSF

- Requirements verified
- Final report pending

JBADS

- Transitioned to a Program of Record
- Now in Source Selection
- Anticipate fielding in 2020

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