Development of a Dry Decontamination System for Personnel
Decontamination and Emergency Response – the NIOSH DryCon System

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Current Decon Practices for Mass Casualty Events - Issues

Wet decontamination is the standard for mass casualty events

- Demonstrated to be highly effective
- Steps in wet decontamination
  1. Remove clothing
  2. Shower
- Wet decontamination can be problematic under certain circumstances
  - Compliance issues with disrobing
  - Re-aerosolization of contaminant
  - Cold weather
  - Water-reactive contaminant
Dry decontamination with DryCon could be another tool

- No disrobing required in public or in inclement weather
- Easily re-aerosolized contaminant removed
- Temperature is of less concern
- No contaminated water for disposal following dry decontamination
Dry decontamination is not a new idea

- NIOSH Clothes Cleaning System
  - Used in the mining industry
  - Air comes from a compressor
- Rapid Dry Firefighter Field Decontamination System
  - Handheld
  - No particle capture
- Air Showers
  - Used for cleanroom entry
  - Air nozzles are not aligned
Forces of Particle Adhesion and Removal

- Forces of particle adhesion ($F_A$)
  - van der Waals
  - Chemical bonds
  - Capillary action of moisture
  - Electrostatic forces

- Forces of particle removal
  - Lift ($F_L$)
  - Drag ($F_D$)
  - Torque ($F_T$)
Factors Affecting Particle Removal

- Particle size
- Air speed
- Properties of the particle and the surface
- Relative humidity
- Residence time on the surface
- Stiffness of fabric
Components of DryCon

- Positive pressure blower
  - Delivers up to 600 cfm at 1 PSI pressure
  - Controlled by a programmable controller and variable frequency drive

- Enclosure
  - Doors on both sides
  - Vertical and horizontal rows of air nozzles
  - Controlled to slight negative pressure

- Exhaust blower
  - HEPA filter for particle capture
  - Rated up to 1600 cfm
DryCon in Operation

- Video link: EPA Decon video.mp4
Test Method Developed

- Fluorescent powder used as surrogate
  - Applied with pesticide duster
  - Amount applied/removed measured with black light and light meter
- Three different types of fabric squares tested:
  - Polyester double knit
  - Cotton denim
  - Firefighter turnout fabric
Fabric squares were attached to manikin on turntable

- Treatment time was 60 seconds
- Fluorescence was measured before and after
  - Two air flow rates were tested, 480 cfm (13,500 feet/min exiting the nozzle) and 540 cfm (15,000 feet/min exiting the nozzle)
  - Nozzle angles of 0° and 10° were tested
Results of Laboratory Testing

- Higher air flow rate was best overall
- Changing nozzle angle was insignificant
- Decontamination of double knit fabric was highest

Mean fluorescence removal efficiency by fabric and blower speed.

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Mean fluorescence removal efficiency (%)</th>
<th>N</th>
<th>Air Flow Rate (cfm)</th>
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<tbody>
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<td>Double Knit</td>
<td>80.9</td>
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<td>480</td>
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<td>80.7</td>
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<td>540</td>
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<td>Cotton Denim</td>
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<td>Firefighter fabric</td>
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<tr>
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<td>56.8</td>
<td>60</td>
<td>540</td>
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Improved results with Linear Ionizer to Eliminate Static Charge

- Firefighter fabric and cotton denim were tested
- Statistically significant improvements in contaminant removal were measured
  - Denim from 70.3% to 76.2%
  - Firefighter fabric from 56.8% to 68.0%
Modifications have made DryCon more adaptable

- Inflatable shelter sets up quicker
- Components modified to run on generator power
- Internal lighting
Proof-of-concept study shows promise of DryCon technology

- Emergency decontamination for dusty substances
- Pre-decontamination before disrobing for wet decontamination
- Decontamination at the end of a work shift