Future Force Warrior:
Soldier Protection and Individual Equipment System

NDIA Chemical Biological Individual Protection Conference

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What is SPIES?

- **S**oldier **P**rotection and **I**ndividual **E**quipment **S**ystem

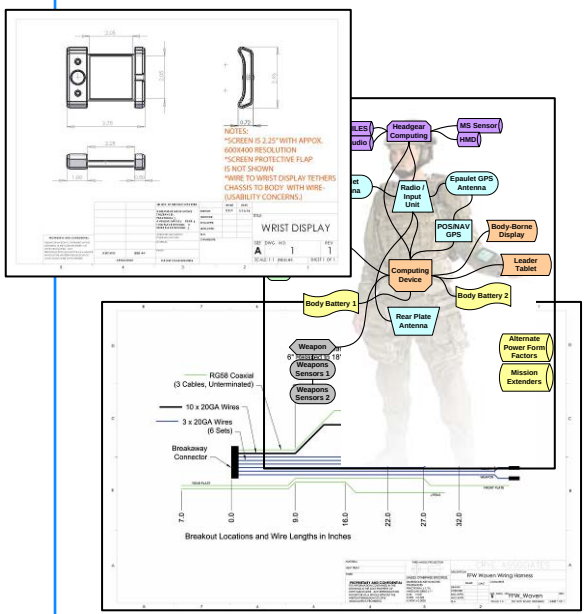
- SPIES is Physical Embodiment
  - Body Armor
  - Load Carriage
  - Physical Integration of Soldier Electronics
  - Uniform designed for Combat
  - Signature Management
  - Hydration
  - CB Protection
  - Fightable form factors

GENERAL DYNAMICS
C4 Systems

What is SPIES?

- **SPIES is also the <u>Physical Bridge</u> between the electronics and the user.**
- Making technology work and making technology work ***on a Soldier, in the field*** are not always the same thing. SPIES helps make the tech. work for a user in the field.

ELECTRONICS TECHNOLOGY



SPIES

FIGHTABLE, PHYSICALLY INTEGRATED, MODULAR SOLDIER-CENTERED, BODY-BORNE SYSTEM

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Multi-function Combat Suit (MFCS)

Optimized for Combat

- **Combat Shirt**
  - ↗ Moisture/Thermal Management Torso utilizing advanced wool materials
  - ↗ High Utility Sleeves utilizing NyCo
  - ↗ Integrated/Removable Modular Elbow Protection
  - ↗ Multi-Environment Camouflage
- **Combat Pants**
  - ↗ Integrated/Removable Modular Knee Protection
  - ↗ Lightly Padded Waistband
  - ↗ Changes underway to improve passive cooling and reduce weight
    - lighter and stretchable NyCo fabric, reduce length of side zippers, eliminate multiple layers of Cordura at lower leg, lighter knee/elbow pads

Weight:

Combat Shirt:	0.9 lbs
Elbow Pads:	0.1 lbs
Combat Pants:	2.6 lbs
Knee Pads:	0.2 lbs

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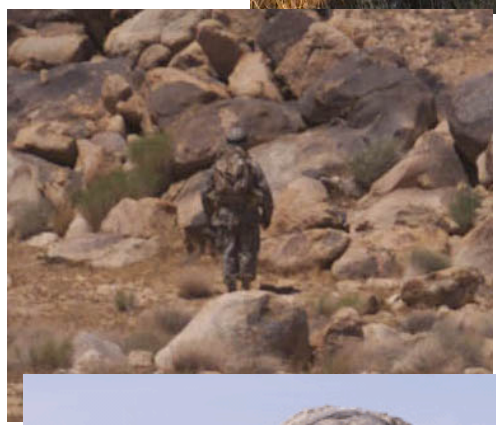
Multi-Environment Camouflage Pattern Evaluation

• **Purpose:** To determine if the FFW MultiCam pattern provides a **significant** improvement in camouflage effectiveness over the Army Universal Camouflage in multiple combat environments.

• **Methodology:** Employ test methodology used by Vehicle community and ATC using digital images.
  • Significantly increases the data set in terms of number of backgrounds, lighting, and number of observers.
  • Measure visual blending of Universal Camouflage and FFW MultiCam in multiple backgrounds.

• **Schedule:**
  Collect calibrated imagery Nov 05 – Jan 06;
  Observer test, Mar- Apr 06; Data Analysis, May – Jun 06

• **Data Goals**:
  • 120 images: woodland, desert, rocky, grassy, urban
  • Scored individually and forced choice
  • 100 Observers from 3 units



SPIES Body Armor/Load Carriage

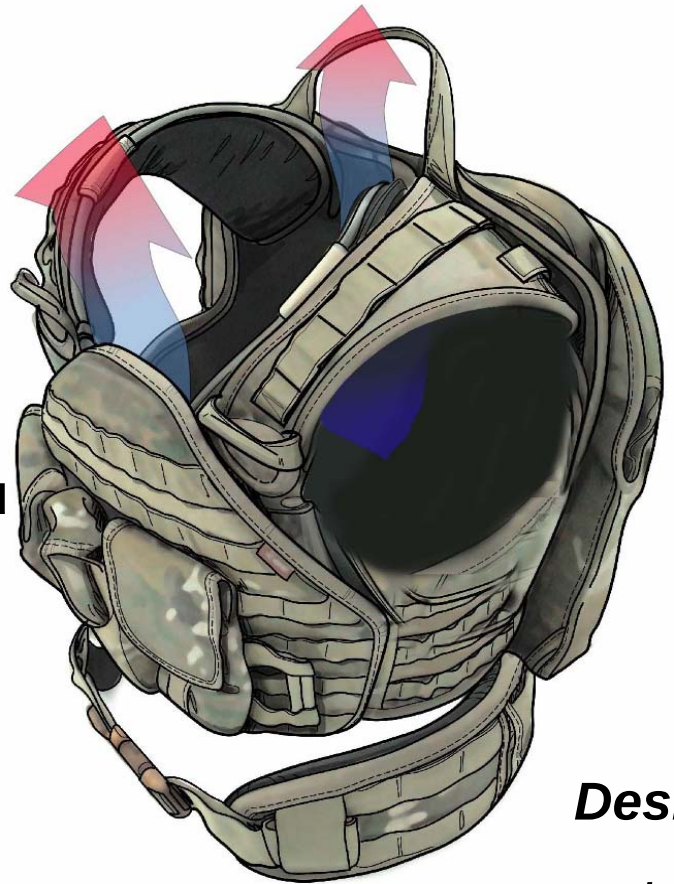
The Armor Chassis and Belt

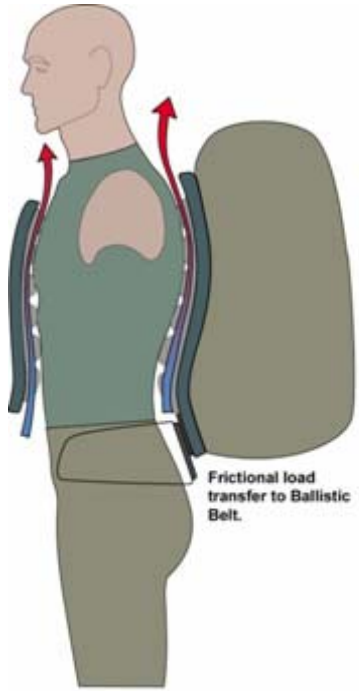
Central Load Carriage, Ballistic Protection, and Thermal Management system.

Provides increased passive cooling, increased mobility, increased ballistic and flame protection, improved comfort, and stabilized load carriage.

Apparel, Load Carriage, and Armor component designs are based on the advantages of this fundamental system architecture.

Weight:
Chassis, sz 2 without plates: 7.0 lbs
Chassis, sz 2 with plates: 18.3
Belt sz 1: 2.2 lbs





Design Challenge:

Balance protection with fightability

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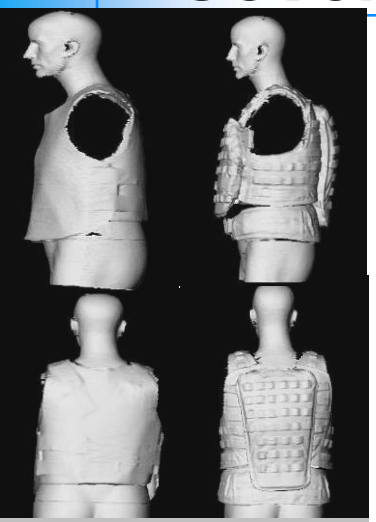
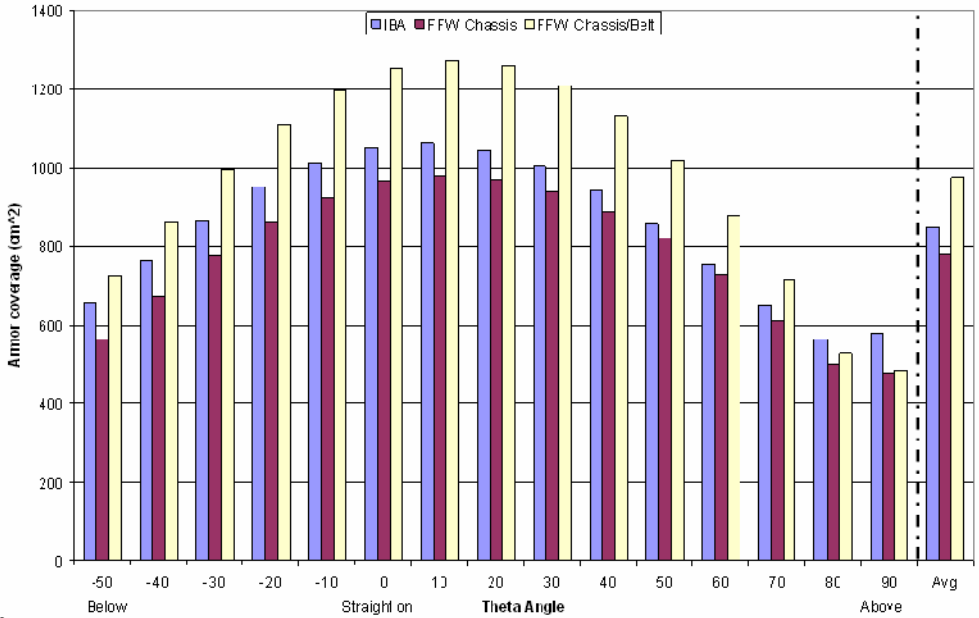
Presented Area of Baseline Ballistic Coverage - Simulated Angles of Attack

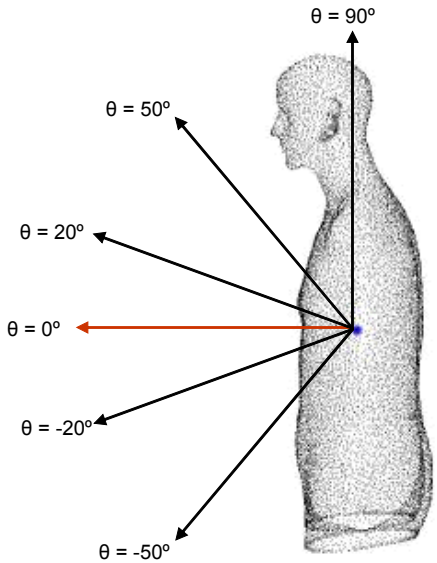


Area of Coverage

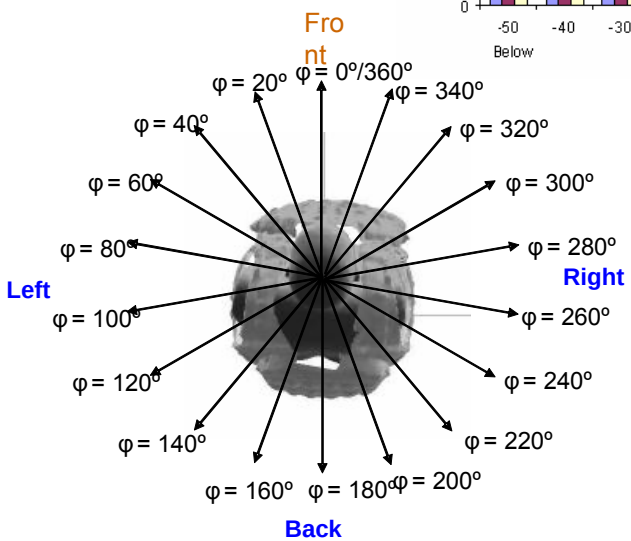
Using 3-D scan data, for each angle ‘theta’, plot the average over all angles ‘phi’.

FFW Chassis and Belt provide 15 % more presented coverage on average.





Theta Angles



Phi Angles

IBA: 850 cm² avg.
FFW Chassis: 779 cm² avg.
FFW Chassis & Belt: 976 cm² avg.

SPIES – Up-Armor Options

BALLISTIC COLLAR-
ACCEPTS PLATE IN REAR

RIFLE
SHOULDER
PLATE

RIFLE
SIDE
PLATE

BALLISTIC BELT
CAN ACCEPT
SIDE PLATES

GROIN PANEL
CAN ACCEPT
SIDE PLATE

BALLISTIC
LEG PANEL
CAN ACCEPT
SIDE PLATE

Up-Armor options are being designed to significantly increase area of coverage for both fragmentation and rifle protection.

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On-the-Move Hydration

- **Chem / Bio Resistant bladder assembly**
  - ↗ CB testing scheduled at Dugway Apr 06
- **Blow molded bladder, 70 oz. capacity**
  - ↗ Holds its shape, yet collapses as water is removed
  - ↗ Easy to insert and remove from carrier
  - ↗ EVA material, 30 mil minimum thickness
- **Hang to dry with no creases for water residue and bacterial growth**
  - ↗ Meets FDA and NSF standards
- **Low projected production cost: $21.50 bladder assembly**

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CB Protection

- **Leverage SOF's Personal Protection Ensemble (PPE) materials and design, with modifications to enhance compatibility with SPIES**
  - Components
    - Selectively Permeable Membrane (SPM) suit
    - High Strength Fluoropolymer (HSF) gloves
    - HSF over-boots
    - HSF integral hood
  - Design Features/Modifications
    - Sleek design for use under chassis
    - Leg and arm gussets
    - Personal Air Ventilation System (PAVS) and Personal Air Purifying Respirator (PAPR)

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Personal Air Ventilation System (PAVS)

- **PAVS: modified GOTS**
  - Evaluated with PAPR modified to increase air flow from 2 cfm to 10 cfm
  - Belt mounted with hip inlet
  - Internal removable manifold distributes air throughout the suit
  - Dual path for developing PAVS (no funding currently available)
    - Modified GOTS item – increase airflow at contractors expense
    - Cooperative Research and Development Agreement (CRADA) – convert developmental PAVS to a CB PAVS

"Performance of the PAVS and PAPR was worth the weight "

"Less performance for less weight was not acceptable"

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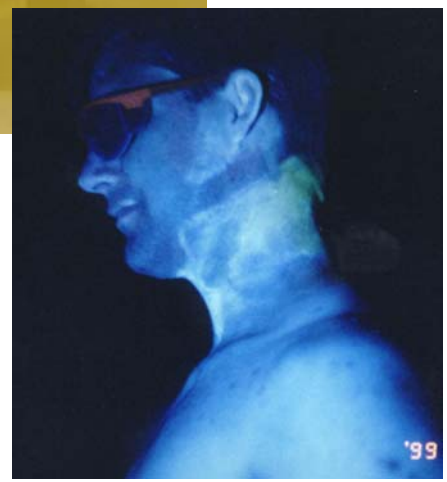
CB Testing Strategy

- **Component level testing is being leveraged from SOF testing**
  - ↗ CWA Swatch testing
  - ↗ Physical Properties Testing
- **System level testing**
  - ↗ Thermal Manikin Testing
    - Completed February 2006
  - ↗ Aerosol Testing
    - Fluorescent Aerosol Screening Tests (FAST)
  - ↗ Chemical Vapor Resistance Testing
    - TBD based on PAVS availability



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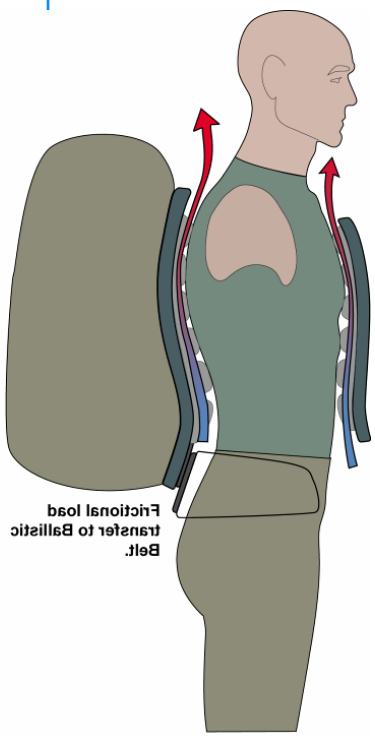
Thermal Management
Passive Cooling

Air flow through chassis off-set



Configuration	Insulation CLO	Moisture Vapor Permeability (I_m)	Perm-Insul Ratio (I_m/CLO)
Land Warrior, 2002 **BDU+BA+LBE**	**1.51**	**0.38**	**0.25**
Land Warrior, 2002 **BDU+CBR+BA+LBE**	**2.07**	**0.27**	**0.13**
SPIES Rev 7+ MFCS, Chassis, Belt, LSDS	1.23	0.40	0.33
ACU, T-shirt, SPIES Chassis and Belt	1.23	0.38	0.31
SPIES Rev 7+ MFCS, Chassis, Belt, LSDS, CB (no PAVS) = CB worst case	1.76	0.21	0.12
SPIES Rev 7+ MFCS, Chassis, Belt, LSDS, CB w/ PAVS = CB mid case	TBD	TBD	TBD
SPIES Rev 7+ Chassis, Belt, LSDS, CB w/ PAVS = CB best case	TBD	TBD	TBD

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System Level Flammability

- Test conducted by N.C. State University, 20 July 2005
- ASTM F 1930, Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Flash Fire Simulations Using and Instrumented Manikin.
- 8 gas burners produce flash fire conditions, average heat flux of 2 cal/cm^{2}sec, 3 and 4 second exposure durations
- Nomex undergarments used to protect manikin sensors; data comparable within this data set only
- Preliminary testing, n=1

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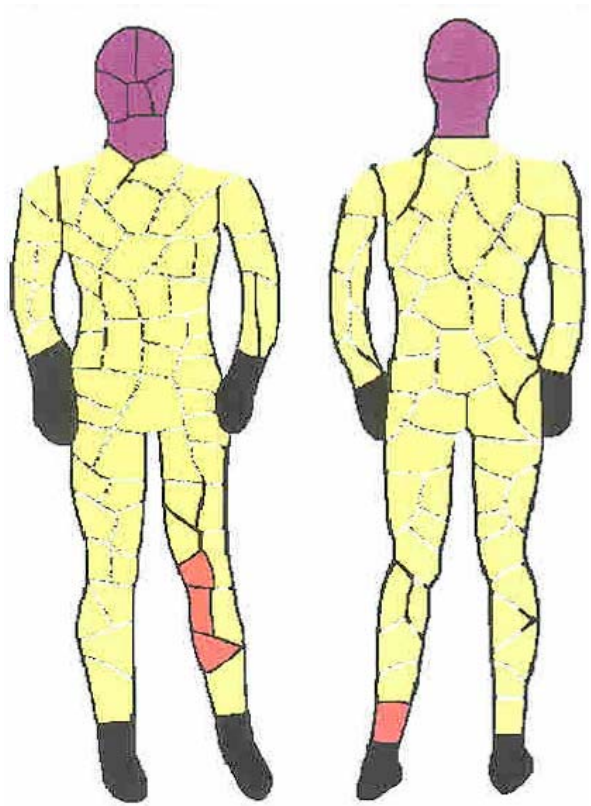
System Level Flammability:
FFW, 4 second exposure

After-burn and melt drip on nylon at lower leg, around knee and elbow pads

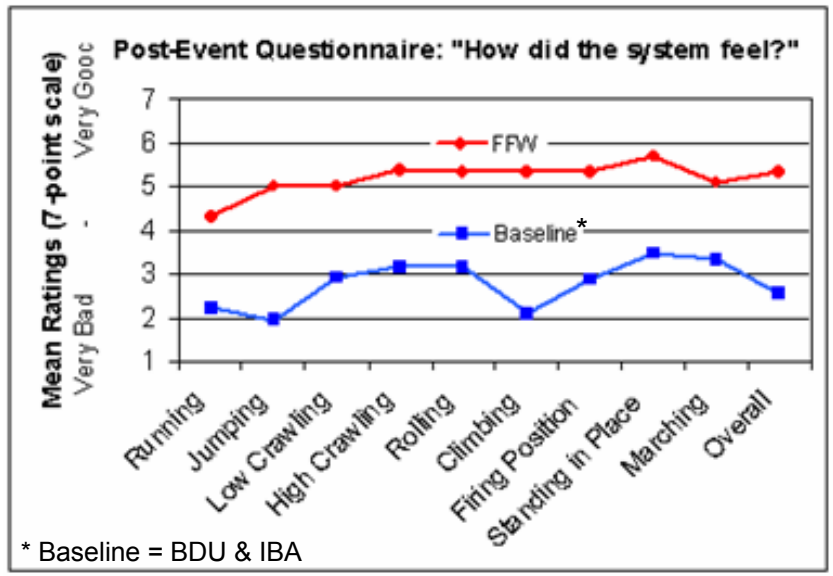
Interior of chassis was unaffected. Slight singeing lower edge of inner pads. 1,000 denier nylon on outside of chassis stayed mostly intact.



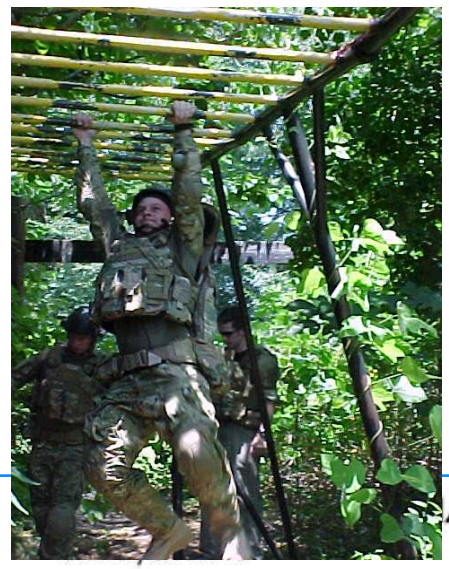
Burn Injury Prediction:
RED 2nd degree burn: 3.28%
PURPLE 3rd degree burn: 6.56%

Improvements attributed to Design features:
Form-fitting uniform, shirt tucked into pants, internal chassis sizing adjustments, 1000 denier nylon armor covering

Integration / Fightability / Mobility



* Baseline = BDU & IBA



Summary

- SPIES is the physical embodiment of the FFW physical protective systems from the neck down.
- CB protection is one piece of the overall SPIES system and is designed to integrate with the entire FFW system.
- Development efforts in CB are on-going and will be proven out through additional laboratory experiments in FY07.

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