

INFANTRY PROTECTION FROM FLAME, NUCLEAR FLASH, CHEMICAL WARFARE AGENTS AND LASER THREATS

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INTRODUCTION

An Advanced Clothing System (ACS) was developed as part of the U.S. Army Natick Clothing Research, Development and Engineering Center Soldier Integrated Protective Ensemble (SIPE) to provide protection for infantry soldiers from flame, nuclear flash, chemical warfare agents and laser energy, while minimizing performance degradation from ergonomic effects, especially heat stress. In addition, the ACS provides visual and IR camouflage and environmental protection in temperate climates with minimum weight and bulk. Included in this report is data regarding the performance of the Advanced Shell Garment (ASG), Advanced Combat Uniform (ACU) and Chemical Vapour Undergarment (CVU). Other items in the SIPE program include: ballistic protective vest; load bearing component; combat boot/gaiter; combat glove; air cooling vest/system; soldier computer and navigation systems; ballistic protective helmet system with integrated respiratory and hearing protection, night vision and target acquisition subsystems.

METHODS

Off-the-shelf or near-term experimental fabrics were selected for phase I:

Clothing item	Fabric	Supplier
Advanced Shell Garment	250 g/m ² PBI/FR Cotton/ Stainless Steel: Goretex II®	Hoechst Celanese/ W.L. Gore
Advanced Combat Uniform	250 g/m ² PBI/FR Cotton/ Stainless Steel	Hoechst Celanese
Chemical Vapor Undergarm.	Saratoga® PJ-7	Tex-Shield/ Blücher GMBH

The ASG is a hooded hip-length parka and trouser ensemble designed to provide both chemical and aerosol protection. The ACU is similar to the standard Battle Dress Uniform. Both garments have improved closures and interfaces with the other clothing items such as gloves and boot for enhanced aerosol protection and are printed with standard Woodland camouflage. The CVU is a two-piece undergarment designed to provide vapor protection. The CVU can be used in three modes to offer greater flexibility to the user, to adjust to various attack scenario's and environments. For example, when worn under the ACU alone, complete protection from vapor and moderate protection from liquid agent is provided with very low heat stress. The ASG can be added over the ACU to provide complete liquid and aerosol protection. The ASG can also be worn directly over the CVU (ie., without the ACU) in hot environments to minimize heat stress.

The ACS is also designed to provide complete environmental protection in temperate climates. It is anticipated that the addition of standard Army polypropylene undershirt and drawers and quilted polyester batt coat and trouser liners to the ACU and ASG will provide sufficient insulation for cold/wet environments. Full scale development of the ACS would include utilization of the Army's advanced microfibre polyester insulation technology which should extend the usage range into the cold/ dry environments.

Possible combinations of these clothing layers were tested for battlefield threats as follows:

Clothing	Flame (1) 2.4 cal/cm ² .s TTF (s)	Nuclear 10 cal/cm ² .s TTP (s)	Laser 10 cal/cm ² .s TTB (s)	Chemical (2) liq 10 mg/m ² .24 h vap 10 mg/m ³ .24 h
ACU/CVU	5.8	NT	NT	NT
ASG/CVU	10.4	NT	NT	NT
ASG/ACU/CVU	10.7	* > 12.3	* > 2	NT
ASG/ACU	NT	* 4.6	* > 2	NT
ACU	3.1	* 0.5	* > 2	NT
ASG	5.4	* 2.8	* > 2	NT
Requirement	3.0	2.0	2	
Laboratory	Hoechst Celanese	TNO-PML	Arthur D. Little	GEOMET

TTF: Time To Failure

TTP: Time To Pain

TTB: Time To Breakthrough

NT: Not Tested

*: Tested with T-shirt material

In addition to this contractor testing, human factors (MANPRINT) and physiological and field evaluations of end items have been conducted by the U.S. Army throughout the program.

RESULTS AND CONCLUSIONS

Phase I data indicates that the ACS provides protection from the specified threats. Testing (including for chemical agents) is underway on the Phase III materials listed below.

Clothing item	Fabric	Supplier
Advanced Shell Garment	175 g/m ² Nomex III®/ Goretex II®/ Nomex knit	Springs/ W.L. Gore
Advanced combat Uniform	Quarapel 250 g/m ² Proban FR™ cotton/ Kevlar®/ P-140 *	Westex/ DuPont
Chemical Vapor Undergarm.	Saratoga® knit PJ-11	Tex-Shield/ Blücher GMBH

* P-140 is a proprietary DuPont antistatic fibre.

REFERENCES

- 1 National Fire Protection Association Standard 1971-1988. Structural Firefighting Protective Clothing.
- 2 CRDC-SP-84010 (1984). Laboratory methods for Evaluating Protective Clothing Against Chemical Agents.

DISCLAIMER

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