Survivability of Collective Protection Systems Subjected to Air Blast Loads

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Tests conducted by the Air Force Research Laboratory (AFRL) and the USAF Force Protection Battlelab demonstrated that M28 liners installed in Tent Extendable Modular Personnel (TEMPER) tents ripped, separated at the zip connections, and failed to maintain pressure when subjected to blast loading by a satchel-sized explosive charge at standoff distances of 100 feet or more, while the parent tents suffered little or no damage at a standoff distance of 65 feet.
The M28 Collective Protection (CP) System is essentially a polyethylene liner used in TEMPER and other rigid frame tents. A filtered ventilation system supplies toxin free air to the liner and maintains a positive pressure slightly greater than the surrounding atmospheric pressure that ensures that the flow of air though small holes or loose seals is outward to prevent flow of contaminated air into the protective system. The TEMPER tent itself consists of a canvas material draped over a frame and staked to the ground.
The M28 liner system consists of 16 foot center sections, end sections, and entry vestibules that are joined by airtight zip-type seals.

Plastic straps with arrowhead type connectors riveted to the outside of the M28 liner attach to the tent frame to support the liner when it is not inflated by the ventilation system.
A tent fitted with the M28 collective protection system (CPS) allows personnel inside the shelter to work, eat or rest without the burden of individual protective equipment. However, this advantage is nullified if the liner has a breach so large that the ventilation system is unable to maintain positive pressure and outward air flow, as through a large tear or failure of a zip seal.
A satchel sized explosive device placed about 100 feet from TEMPER tents fitted with the M28 CPS did only minor damage to the tent and frame. Damage consisted primarily of stakes pulled from the ground and loosened tension lines.
The same satchel sized explosive device caused zip-seals in the M28 liner to separate, and resulted in a complete loss of positive pressure inside the liner.
Tears in the liner also contributed to the complete loss of overpressure inside the M28 liner after the explosive blast.
Tears are probably a result of the point stresses created where the arrowhead anchoring straps attach to the liner; as the liner is compressed by the pressure wave the anchor straps constrain the liner’s motion.

Failure of the seals is likely due to the unequal distribution of pressure on the front and back side of the structure.
Data from tests on TEMPER tents with the M28 CPS highlights a significant shortcoming of the M28 liner; the survivability of the liner to air blast is not well balanced with the survivability of the parent tent.
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- Partners at Virginia Tech are developing a computer model of the TEMPER-M28 system capable of predicting the response of the shelter to dynamic loads. Field tests are being conducted at AFRL to measure the response of the system to actual blast loads.

- The goal is to create a software model that can be used to analyze other soft-sided shelter systems, including future CPS designs, and to identify remedies to improve blast survivability of the existing TEMPER-M28 shelter.
Collaborators

- USAF Force Protection Battlelab
- U.S. Army Soldier Systems Command
- Virginia Polytechnic Institute and State University
- Production Products Mfg. (manufacturer of the M28 liner)