REDUCTION OF SPINAL IMPACT WITH HACS CUSHIONING

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Abstract
Impact injuries continue to be a problem for military and civilian personnel in aircraft, boats, trucks and armored vehicles. Spinal injuries may occur from single impact events such as a crash in a helicopter or fixed-wing aircraft, as well as repetitive impacts in armored vehicles over rough terrain or small boats running in heavy seas. Protective seats can be engineered to dissipate much of the impact energy before it is transmitted to the body. Stroking hydraulic seats are used in some aircraft, but in older models, there is not sufficient room to install them. Foam cushions can be helpful; however, in some cases, they have failed to provide the needed protection and can actually increase the potential for injury. The training of personnel in sophisticated military vehicles and aircraft is expensive, and may careers are shortened or ended by impact injuries sustained during either training or field operations.

For the past twelve years during multiple Small Business Innovation Research (SBIR) programs for HHS and DOD, investigators at Triangle Research and Development Corporation (TRDC) have developed an advanced Hybrid Air Cushioning System (HACS) that shunts much of the impact energy laterally instead of through the protective cushion. Programs for HHS investigated how thin protective body padding and bicycle helmet liners could improve safety for adults and children. Programs for DOD Special Operations Command (SOCOM) have demonstrated how HACS could significantly reduce blunt injury trauma beneath body armor. Another program for SOCOM also showed the utility of HACS for a helmsman's neck collar for use in small boats in pounding seas.

In a more recent SBIR program for the NAVY, a HACS seat cushion was designed and tested which dissipated more than 40% of the vertical impact energy with choked flow through a series of internal bleed ports and passages molded into the cushion, thus significantly reducing the potential for spinal injury during both single and multiple impacts. The new HACS Cobra Cushioning System (CCS) was specifically developed for the Cobra AH-1W helicopter and the Navy Air Systems Command (NAVAIRSYSCOM) because this older attack helicopter does not have stroking seats or other crashworthiness systems. A unique computer simulation program was developed and used to optimize the thirteen variables in the HACS seat cushion. Over 200 experimental drop tests were conducted in the impact test laboratory at TRDC using Hybrid III 5% female and GARD 50% male mannequins. Additional testing was conducted using the Navy Crew System Horizontal Accelerator at the Naval Air Station at Patuxent River, MD. Using instrumented mannequins (5%, 50% and 95% male) weighing from 177 to 258 lbs, the NAVY experimental results showed that a 3-inch HACS seat cushion was 40% more effective in reducing the lumbar loads transmitted during the 23g impact tests than any other aircraft seat cushion tested. The novel and patented HACS cushion can also be designed to maximize energy absorption while minimizing potentially dangerous rebound. The superior performance of the HACS cushioning is expected to reduce injuries to pilots and should be applicable to other problems where either single or repetitive impact loadings are a problem.

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