

National Security



Protecting Our Soldiers

INL's survivability programs provide detection, avoidance and defeat of ballistic and explosive threats to the nation's personnel, vehicles and critical infrastructure deployed worldwide.

Idahoa National Laboratory has a rich history in armor development and survivability solutions. The laboratory's focus in this area began more than 20 years ago, when the lab began manufacturing the heavy armor for the M1 Abrams tank. With a fleet of more than 9,000 units, and armor so strong it can survive a direct hit, the Abrams tank is recognized as the world's finest heavily armed and protected ground combat vehicles.

Today, INL's heritage in armor development and survivability

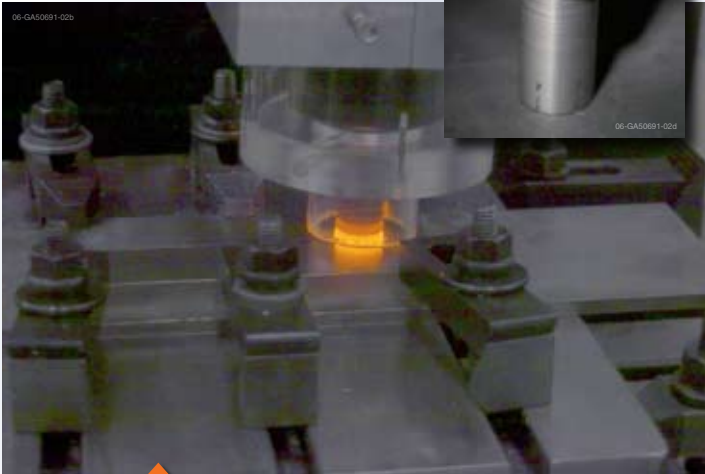
continues with ongoing production supporting the Abrams program, and advanced research, development and prototyping of lightweight higher-performance armor for use on combat and combat support vehicles within the Department of Defense's current armored force and future combat systems.

As a U.S. Department of Energy national laboratory, INL conducts a broad range of basic and applied research, focusing on comprehensive survivability solutions to meet the ever-

changing threat of asymmetrical warfare. INL provides solutions that capitalize on the laboratory's superlative capabilities in survivability assessment, materials engineering, integrated design and award-winning manufacturing processes.

INL's government-industry research is focused on the armor needs of future combat systems. This process allows armor technology to be scaled up or down to meet multiple applications. The philosophy

Continued next page



INL's capabilities in survivability include the joining and friction stir welding of titanium armor plates at the laboratories comprehensive research and development facilities.

Continued from front

underlying INL's research is to consistently achieve high-performance armor manufacturing solutions composed of accessible materials and innovative manufacturing processes which provide affordable products to the military, law enforcement and homeland security personnel.

The laboratory is one of the nation's few centralized locations performing comprehensive materials research and development, advanced modeling, simulation, testing and evaluation that leads to rapid armor prototypes and limited-run production. The laboratory's depth spans from engineering to prototype to field trials providing validated manufacturing readiness solutions for industry scale-up when needed.

INL's Survivability Program

INL's survivability program focuses on rapid development, testing and prototype qualifica-

tion of integrated ballistic and blast survivability solutions, including friction stir alloying armor, roll-bonding and high-performance polymers that provide enhanced protection for the nation's military.

INL's integrated team of experts provides program management, design, system analysis, engineering and prototype manufacturing skills necessary to achieve cutting-edge survivability solutions and rapid field implementation.

The lab's experts can facilitate technology transfer of research and development products to manufacturing processes that assure implementation of survivability hardware for personnel, vehicles, equipment and facilities against current and emerging ballistic and explosives threats.

INL's Survivability Program is organized to rapidly respond to military and government needs for rapid solutions, meeting the ever-changing threat of asymmetric warfare.

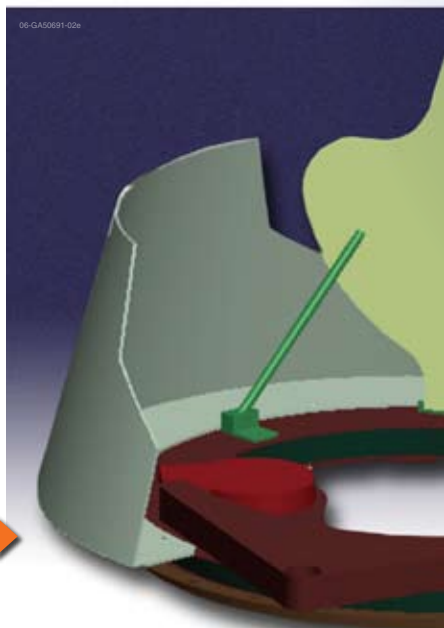
The survivability program provides a closely woven network of capabilities at one secured and controlled location. The service is divided into eight centrally organized areas. Research areas include:

- Armor and Barrier Development is focused on the development of cost-effective armor materials and systems and manufacturing processes

INL is developing a prototype of a lightweight turret apron HMMWV cab, integrating INL's conformal SiC tiles into a composite armor system for IED and level IV ballistic threats.

for light, medium and heavy armor systems designed to defeat current and emerging ballistic, improvised explosive devices, rocket-propelled grenades and explosive flyer plate threats.

- INL's Ballistic and Blast Modeling and Simulation team uses state-of-the-art techniques allowing rapid validation of test results and prediction of highest armor and blast performance achievable for a given system.
- Ballistic and Blast Testing & Evaluation is conducted on INL's unique 890-square-mile desert landscape and secure facilities including the explosives test range and live fire test range.
- Critical Infrastructure Vulnerability Assessments includes a team of technical experts in physical and cyber-security threat assessments at facilities and industrial control system processes.
- Specific Manufacturing Capability is the nation's



premier facility manufacturing heavy armor for the Abrams tank.

- Explosives Detection Technology Development and Assessment serves to provide rapid solutions in detection technologies and independent testing and evaluation of solutions developed by others to support military and government agencies worldwide.
- Ballistics and Explosives Attack Avoidance Technology Development supports solutions to prevent terrorist attacks by providing resources and testing facilities, including a wireless test bed for radio frequency device testing.
- Technology Transfer to the commercial sector is facilitated at INL via several contracting vehicles with industry and government partners. INL-developed manufacturing processes in the prototype stage can be used to allow rapid field trials

leading to expanded production with industry partners.

Materials Research

INL has a comprehensive understanding of materials behavior in aggressive and harsh environments. For more than half a century, the laboratory has applied knowledge and background in material characteristics to innovative technologies, including diverse sensor integration, defense materials, nuclear fuels with improved nonproliferation characteristics and light-armor development and manufacturing. Current survivability research includes:

Ceramic Armor:

- Pressureless-sintered SiC
- Pressureless-sintered SiC-TiB₂
- Transient liquid-phase-aided pressureless-sintered Aluminum Oxy-nitride (ALON)

Metallic Armor:

- Thermo-mechanical processing of Ti 10-2-3
- Plasma arc spray processing of Ti laminates
- Plasma arc spray processing of Al-alumina laminates

Material Bonding Processes:

- Brazing SiC to Ti
- Roll-bonding Ti laminates
- Friction stir-welding Ti
- Friction stir alloys of metallic-ceramic composition

Encapsulated Ceramic Armor:

- Spray-formed Al encapsulation of SiC
- Titanium encapsulated ceramic

Composite Armor:

- Polymer-ceramic
- Polymer-ceramic-glass, Topologically Controlled Lightweight Armor

Barrier Systems

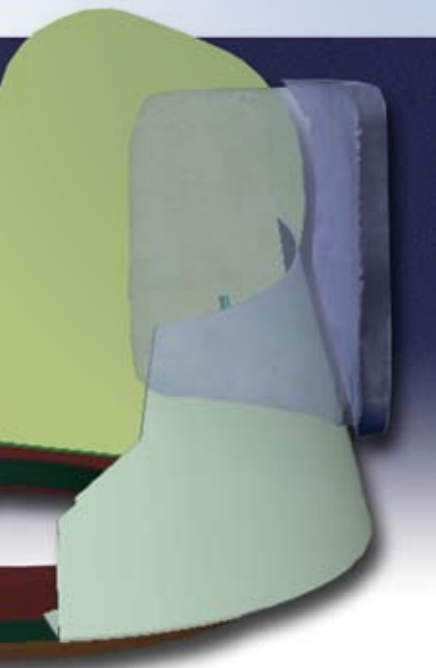
- Pumice protection barriers for explosives/ballistic threats
- Vault doors for EFP threats

Continued on back

INL researcher Dr. Henry Chu prepares an armor sample for ballistic testing at the laboratories armor penetration test bed.



The images above display the results of several high-caliber impacts on two armor samples under evaluation at INL.



Continued from previous page

Modeling & Simulation

- Ballistic modeling – CTH, DYNA, EPIC, ZEUS, and ALEGRA

Testing & Evaluation

With 890 square miles of isolated and secure terrain, INL has the ability to merge technical expertise with physical assets. The high-desert landscape and dedicated physical security test beds include:

Live Fire Test Range:

- Seven ranges spanning from 50 – 1,200 yards
- Indoor range - small arms rifles to 30 cal. AP
- 14.5 mm
- 20 mm
- 30 mm

- RPG and higher (EFP)
- Chronographs

Mass Detonation Area:

- Single target or arena tests to 20,000 lbs. TNT equivalent
- High-speed cameras and data acquisition systems
- Highly-trained staff with diverse background in explosives impacts

Flexible, Secure Facility Manufacturing

- High temperature
- Radioactive and nonradioactive materials processing
- Armor, structural and shielding applications
- Ferrous and nonferrous metal alloys

- Metal matrix composites

Battle-Proven Results

For more than two decades, INL has quietly been a recognized leader in unique survivability solutions for special military forces, law-enforcement agencies and homeland security personnel. INL's expertise in confidential design, analysis and testing infrastructure combined with its engineering discipline is helping develop cost-effective survivability materials and systems that are saving lives from America's home front to global battlefields.

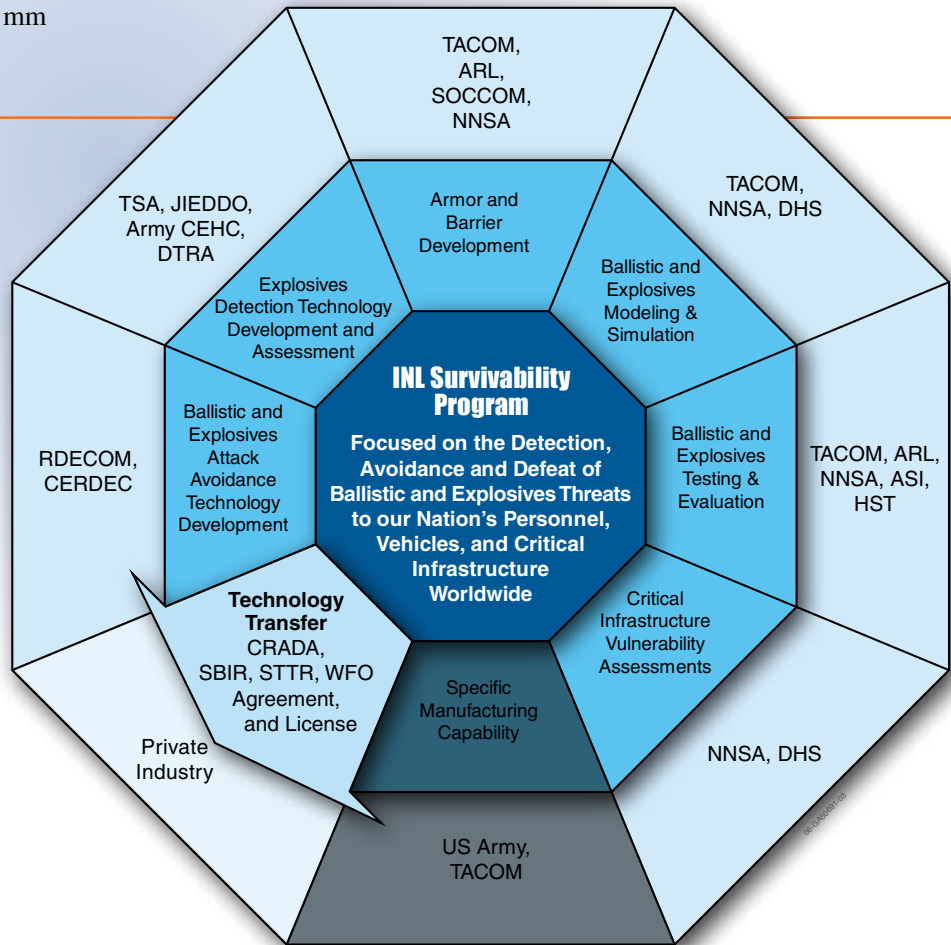
For more information

Dr. John Garnier
208.526.9388
John.Garnier@inl.gov

Dr. Henry Chu
208.526.7514
Henry.Chu@inl.gov

Gary Thinnnes
208.526.9298
Gary.Thinnnes@inl.gov

A U.S. Department of Energy
National Laboratory



INL's Survivability Program is organized into eight capability areas to rapidly respond to military and government needs and to develop solutions to meet the ever changing threat of asymmetrical warfare.