U.S. ARMY

DEVCOM GROUND VEHICLE SYSTEMS CENTER

GVSC LABORATORY CAPABILITIES SOURCEBOOK

U.S. ARMY GROUND VEHICLE SYSTEMS CENTER

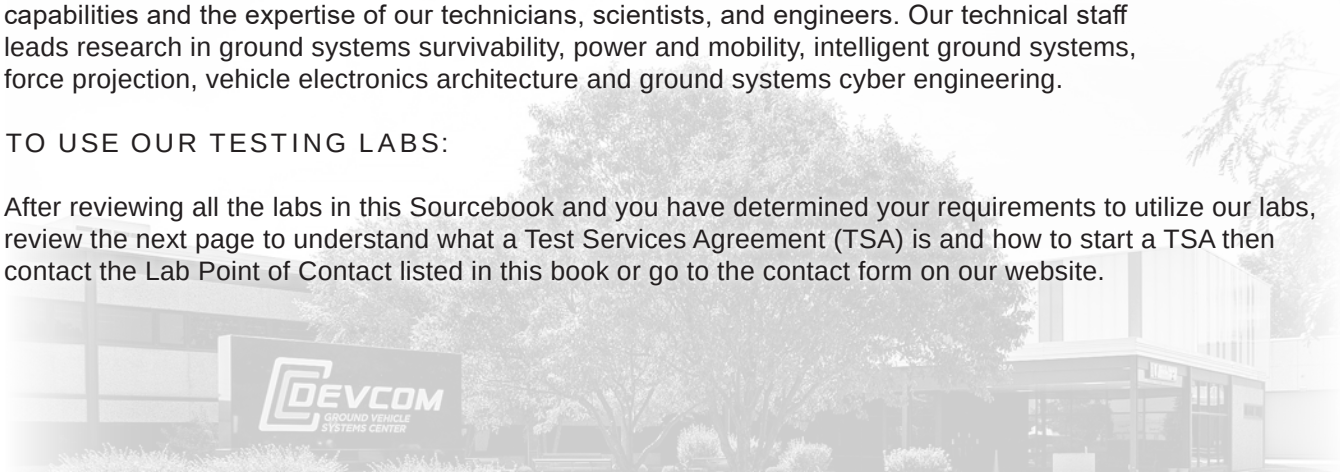
2023

WELCOME TO THE GVSC LABORATORY CAPABILITIES SOURCEBOOK

At the U.S. Army Ground Vehicle Systems Center (GVSC), our goal is to provide warfighters. with advanced technological solutions to ground vehicle systems challenges. This handbook is designed to introduce you to GVSC's unique laboratory and testing. capabilities and the expertise of our technicians, scientists, and engineers. Our technical staff leads research in ground systems survivability, power and mobility, intelligent ground systems, force projection, vehicle electronics architecture and ground systems cyber engineering.

TO USE OUR TESTING LABS:

After reviewing all the labs in this Sourcebook and you have determined your requirements to utilize our labs, review the next page to understand what a Test Services Agreement (TSA) is and how to start a TSA then contact the Lab Point of Contact listed in this book or go to the contact form on our website.



OUR MISSION: Accelerate delivery and sustainment of ground system capabilities to our partners ensuring overmatch for our Warfighters.

OUR VISION: The center of excellence for DoD ground vehicle systems modernization and sustainment solutions.

GVSC'S FOUR PRIMARY MISSION AREAS:•

- Develop and integrate the next generation technologies to ensure ground system dominance.
- Provide world class functional engineering expertise to our PEO CS & CSS and PEO GCS partners.
- Provide world class sustaining engineering expertise to our TACOM partners.
- Recruit and develop the engineering talent to achieve the above.

GVSC TEST SERVICES AGREEMENT

The Ground Vehicle Systems Center (GVSC), located in Warren, MI on the Detroit Arsenal, is the U.S. Army's laboratory for developing advanced military ground vehicle technologies. GVSC has unique laboratory and testing capabilities and the expertise of our technicians, scientists, and engineers to support your testing needs.

GVSC Laboratory Facility/Capabilities are available for Testing Purposes

1. Purchase testing "at cost" (Laboratories do not make a profit).
2. Government does not derive any right in or to the purchaser's Intellectual Property.
3. Test Results are confidential and may not be disclosed outside of the Federal Government without the consent of the persons for whom the test are performed.

AUTHORITY

Test Services Agreements (TSAs) are authorized by 10 USC 4892. The law authorizes the directors or commanders of government laboratories, centers or other facilities to make available to any person or entity, at a prescribed fee, the services of the government facility for the testing of materials, equipment, models, computer software and other items.

WHEN A TSA IS APPROPRIATE

TSAs must involve a "unique" government capability and should be used if the service is to be provided by the laboratory with no technical collaboration by the partner. The service performed must legitimately be the "testing of materials, equipment, models, computer software or other items." A TSA is not appropriate for research studies or investigations. Neither does it authorize the sale of products – just services. The entity requesting the laboratory's services must establish in writing that provision of the services will not constitute undue competition with the private sector and that the service requested does not involve expansion of laboratory capabilities or facilities, even if the requesting entity offers to finance the expansion.

WHO MAY PARTICIPATE IN A TSA

- **Private Industry (U.S. or foreign)**
- **Nonprofits (U.S.)**
- **State, local, or tribal governments (U.S.)**
- **Academic institutions (U.S. or foreign)**

HOW TO START A TSA

Go to our website, review the GVSC Laboratory Capabilities Brochure to see if our labs fit your needs.

https://www.usarmygvsc.com

U.S. ARMY Ground Vehicle Systems Center • 6501 E. 11 Mile Road | RDTA | Warren, MI 48397-5000

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DURABILITY TEST LABORATORY (DTL)

The Durability Test Lab (DTL) provides a one-of-a-kind ability to introduce real world environmental loads into test specimens while utilizing the controlled, repeatable environment of a laboratory. Rapid, cost-effective testing is utilized to make validated engineering decisions for the integration of any Army Ground System technology. As an ISO 17025 Accredited Lab the quality and utility of the data generated can be trusted to make informed engineering decisions.

POC: Robert Page

DURABILITY TEST LABORATORY (DTL)

ELECTRO-DYNAMIC SHAKER TABLE

These shaker tables provide the capability to perform high frequency, multi-axis (via one-axis at a time) testing to Military Vibration Standards Test. They are also capable of producing simulated road vibration. This supports multiple tracked and wheeled vehicle military programs, Urgent Operational Needs (UONs), and fleet modernization initiatives.

CAPABILITIES

These electro-dynamic shakers use a slip table to provide the capability to test 3 orthogonal axes of vibration from 5-2000 hz. This type of testing is the standard for high frequency component testing.
It is very repeatable and controlled, which makes comparisons of different component options very easy. The addition of the thermal chamber allows for the inclusion of temperature cycles (-60F to 160F) while the parts are undergoing vibration, which has been shown to be critical in some materials such as plastics.

BENEFITS

Lab testing of components and subsystems save significant time and money compared to running traditional proving ground testing. This equipment provides a growing capability of high frequency vibration and shock for large payloads. Testing in a lab allows for replications of test profiles in a controlled, repeatable environment.

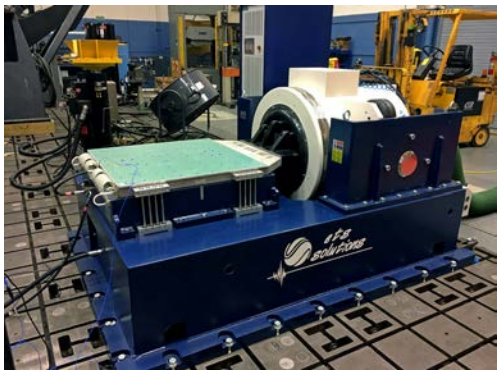
RIG STATISTICS

- Max Actuation Force: 55,000 lbf Random
- Control Bandwidth: 5 to 2,000 hz
- Max Payload: 12,000 lb
- Table Area: up to 5 ft x 5 ft
- Number of Data Acquisition Channels : 32

POC
Robert Page
robert.d.page35.civ@army.mil

T5500 ED shaker with test component

ETS 748 ED Shaker with Environmental Chamber



ETS 748 Shaker

DURABILITY TEST LABORATORY (DTL)

FULL VEHICLE ENVIRONMENTAL CHAMBER (VEC)

This test rig is used to evaluate vehicles in extreme ambient temperatures, representing the most severe conditions that a vehicle may be exposed to during use. The chamber may be used for static or dynamic temperature and humidity-controlled tests.

CAPABILITIES

This rig can accommodate most Army wheeled vehicles. The operating range of the VEC is -60°F to 185°F with full humidity control up to 149°F. Shake testing at temperature is also available with height restrictions on the vehicle. Frequently used for cold weather kit evaluations and cold start tests.

BENEFITS

- Reduced test duration via 24/7 testing options.
- Controlled environment for repeatability of previous test conditions.
- Ability to conduct thermal vibration tests.

RIG STATISTICS

- Minimum Temperature: -60°F
- Max Temperature: 185°F
- Full humidity control from 20% to 95%
- Humidity Limitations: -40°F dew point at maximum dry-bulb temperature of 149°F
- Internal Dimensions
- Length: 371”
- Width: 186”
- Height: 180”

POC
Robert Page
robert.d.page35.civ@army.mil

MMPV II inside VEC

M-ATV inside VEC

VEC

DURABILITY TEST LABORATORY (DTL)

FULL VEHICLE SHAKERS (N-POST)

The Full Vehicle Shaker, or n-Post Test Rig, is capable of testing some of the largest wheeled vehicles in the Army's fleet. This tried-and-true technology is a valuable addition to any evaluation effort.

CAPABILITIES

This test rig is a tire coupled roadway system capable of testing most Army wheeled ground systems. The actuators can be configured in several ways to accommodate various axle or wheel spacing configurations. It can input most loads seen while exercising to the vehicle Operational Mode Summary on Army Test Courses.

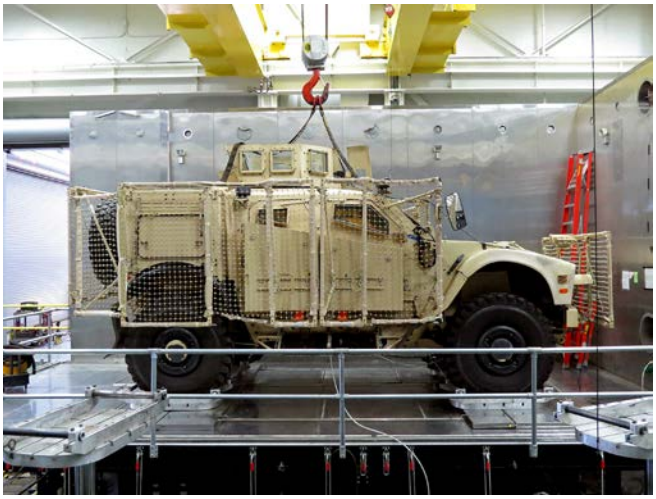
BENEFITS

- Reduced test duration via data editing, correlation, and 24/7 test option.
- Observation of test specimens in motion allows the test engineer to evaluate the vehicle negotiating difficult or problem-causing terrain.
- Controlled environment for repeatability of previous test conditions, eliminating changes in motion due to time, the driver, and weather or test parameters.

RIG STATISTICS

- Max Force Rating: 38,000 lbf.
- Max Displacement: +/- 20 in.
- Up to 5 axles tested concurrently
- GVW up to 80,000 lbs.
- Up to 96 channels recording
- 8 actuators, 38,000 lbf. 20 in. stroke
- 8 actuators 25,000 lbf. 20 in. stroke
- 5 actuators 11,000 lbf. 14 in. stroke
- 4 actuators 11,000 lbf. 12 in. stroke

JLTV being installed on simulator



M-ATV on simulator

Commercial electric truck on simulator

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Robert Page
robert.d.page35.civ@army.mil

DURABILITY TEST LABORATORY (DTL)

HEAVY SUSPENSION SYSTEM TESTER

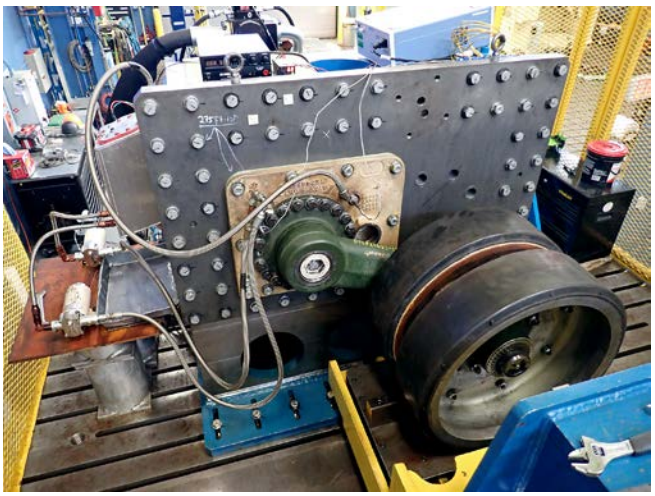
The heavy suspension tester can validate the integration of new components quicker than traditional full vehicle testing at a proving ground. Testing on this rig is especially advantageous where large sample sizes, iterative component design changes, or comparative design analyses are needed. The tabletop above the vertical actuator allows for complex test setups, and large fixtures to be installed. The test controller allows for multiple degrees of freedom to be installed for complex test kinematics.

CAPABILITIES

The test rig is referred to as the Suspension Test Analysis Rig (STAR) The STAR can conduct durability testing of suspension systems, including road arms for tracked vehicles. It is capable of extreme velocity and can simulate shock events in line with MIL-STD 810. Utilizing a head expander, or the integrated t-bed, the STAR can perform tests on a wide range of test items, and systems. The multi-degree of freedom control system allows for actuation of suspension components in all the directions they would be loaded in the field.

BENEFITS

- Reduced test duration via data editing, Reduced test duration via data editing and 24/7 testing operations.
- Multiple Degree of Freedom allows for targeted failure modes and faster test times.
- Reconfigurable table and fixtures allows for multiple components to be tested sequentially and very quickly



Track Suspension Components on STAR

Rotary Actuator

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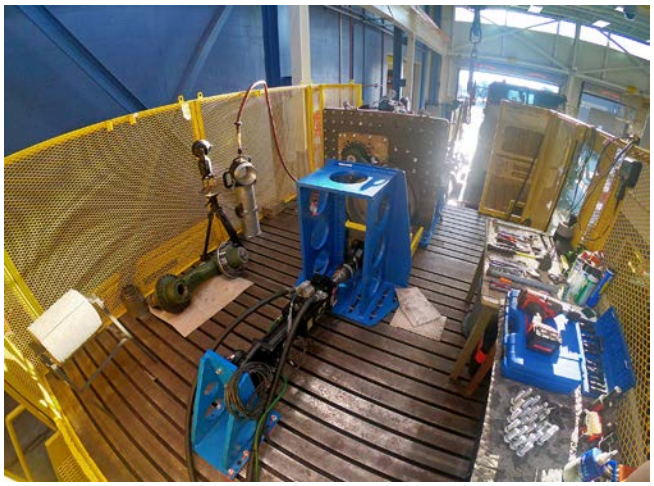
DURABILITY TEST LABORATORY (DTL)

HEAVY SUSPENSION SYSTEM TESTER

RIG STATISTICS

- Force Rating: 72,000 lbf
- Max Displacement: +/- 10 in
- Max Velocity: 400 in/s
- Test item Dimensions: 120 x 174 in
- Head Expander Size: 50.5 x 50.5 in
- Shock Analysis
- Suspension Sub-Assemblies
- Quarter Car Testing
- Seat Shock Characterization
- Armor Shock Characterization
- Floor Blast Mat Characterization



Lateral Actuator

POC
Robert Page
robert.d.page35.civ@army.mil

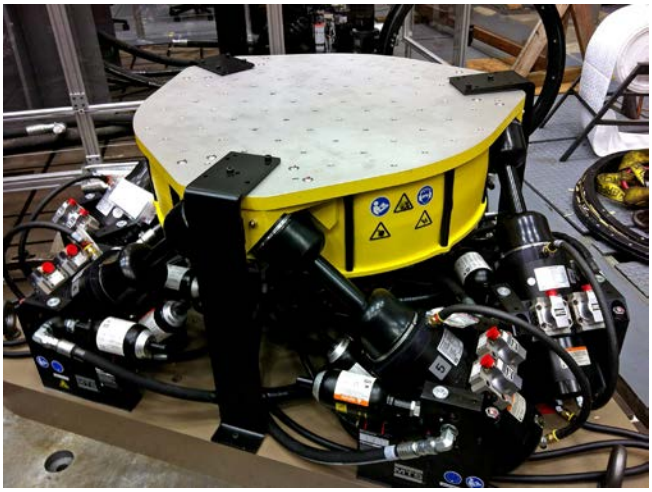
DURABILITY TEST LABORATORY (DTL)

MULTI-AXIS SHAKER TABLE (MAST)

This shaker table provides capability to perform multiaxis testing in six concurrent degrees of freedom while controlling temperature to replicate simulated road vibration and environmental loads. This supports multiple tracked and wheeled vehicle military programs, Urgent Operational Needs (UONs), and fleet modernization initiatives.

CAPABILITIES

This test rig is a 6 degree of freedom, multi-axis shaker capable of testing any Army ground or air systems to a vibration profile. It can precisely replicate most component vibration input loads seen while exercising to the vehicle Op Mode Summary on Army Test Courses. Vibration testing on a component level can be utilized as a valuable design tool to discover durability issues and accelerate redesign for a ruggedized product. First Article Test (FAT) and product acceptance testing can also be performed. If the customer requires, UUT's often can be tested in an operational state, include Units under test (UUT) function testing, or be combined with an environmental chamber.



MAST

BENEFITS

Lab testing of components and subsystems saves significant time and money compared to running testing on full vehicles. This equipment provides a unique capability of high-frequency multi-axis vibration. The lab controls allow for replication of test profiles in a controlled, repeatable environment.

RIG STATISTICS

- Max Displacement: +/- 1.2" in X / Y / Z
- Max Velocity: +/- 30"/s in X / Y / Z
- Max Acceleration: +/- 20g in X / Y / Z (empty table)
- Control Bandwidth: 0 to 500 hz
- Temperature Range -60oF to 160oF
- Max Payload: 1,000 lb
- Table Area: up to 3 ft x 3 ft

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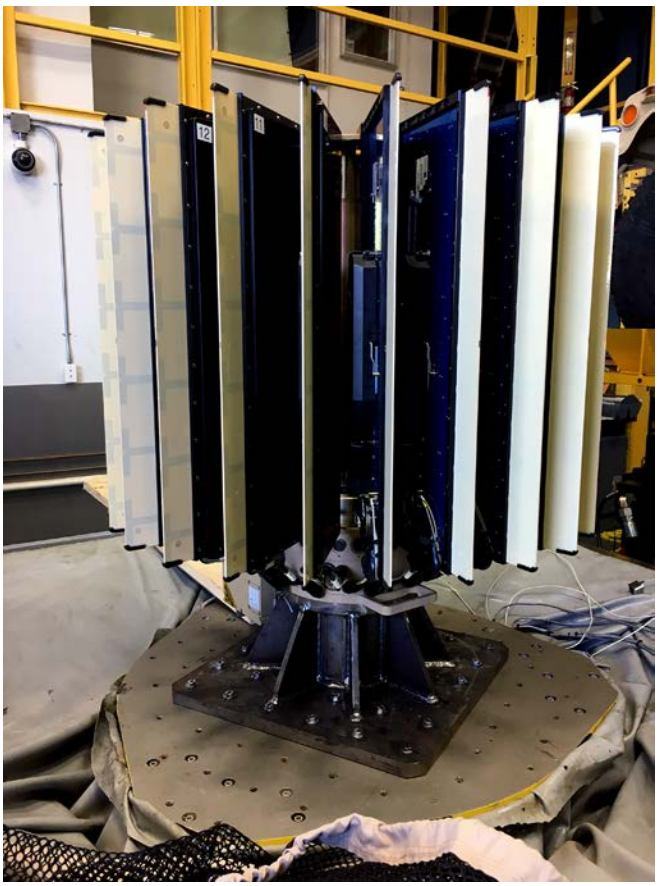
DURABILITY TEST LABORATORY (DTL)

MULTI-AXIS SHAKER TABLE (MAST)

MAST with environmental chamber



Electronic components on MAST

POC
Robert Page
robert.d.page35.civ@army.mil

NOISE AND VIBRATION DATA ACQUISITION AND ANALYSIS

The GVSC team has high-frequency and high-channel count data acquisition capabilities for most measurement types. In addition, the GVSC team has expertise in the analysis of the data that includes acoustics, vibration, durability, and sound quality.

CAPABILITIES

GVSC has 100-plus channels of Siemens Scadas data acquisition that can be configured to collect data from any type of measurement including vibration, forces, strain, displacement, temperature, sound, torsion, pressure, CAN-bus, and GPS. The system can be configured to collect data at multiple sampling rates from 0.5 Hz up to 100 kHz, allowing GVSC to collect a wide range of measurements on large systems such as a full vehicles. With this capability the team has a better understanding of what is happening on a system as it is used in the field and is able to collect relevant data to feed both the internal testing capabilities and feed data to other test centers. GVSC has 28 channels of Bruel a& Kjaer LAN-XI data acquisition that can be configured to collect noise and vibration data. Although the system was built to conduct MIL-STD-1474E aural non-detectability data collection and analysis, an additional benefit over conventional MIL-STD-1474E data collection is that all 24 measurement points are recorded simultaneously, which means the environmental conditions are identical for each measurement point. Simultaneous measurements allow evaluation of moving vehicles using MIL-STD-1474E.

BENEFITS

The Scada system is expandable and has been used to collect vehicle level data that totaled 484 channels of measurements. This program involved the determination of forces in the Abrams running gear, but given the large dataset, the data is also being used by other customers.

The LAN-XI system has been used to collect data for many vehicle platforms including the Small Multipurpose Equipment Transport (S-MET). Abrams, Bradley, Stryker, M109, JLTV, and HMMWV.

This capability allowed the team to:

- Set and evaluate S-MET vehicle acoustic requirements;
- Set, develop, and evaluate the requirements for the Abrams ECP1 Auxiliary Power Unit (APU);
- Quickly react to a request for vehicle acoustics improvements on the JLTV, resulting in an exhaust muffler being added to support the initial design.

Full vehicle test using the Scada system

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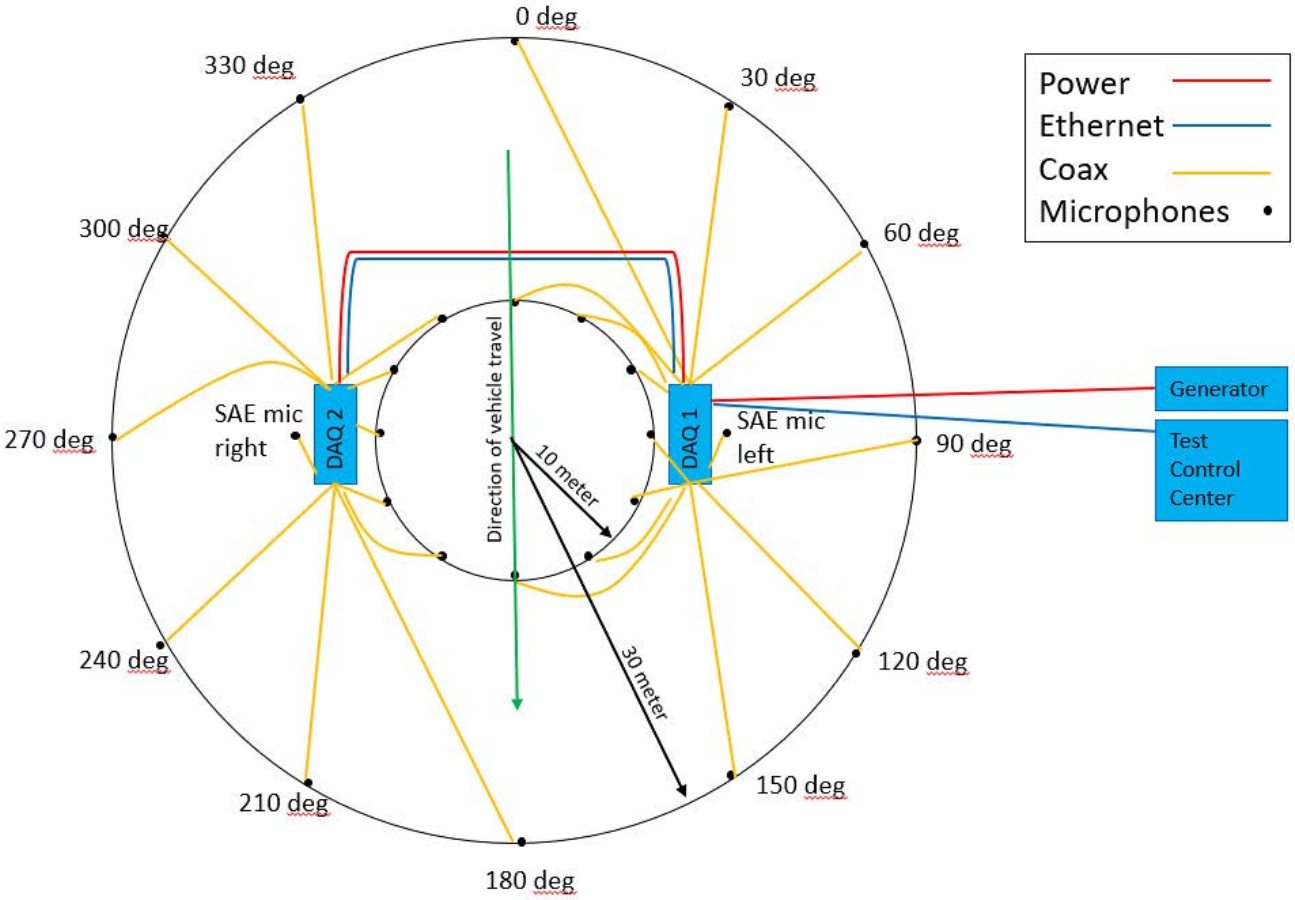
NOISE AND VIBRATION DATA ACQUISITION AND ANALYSIS



MIL-STD-1474E data acquisition setup grid

POC
Robert Page
robert.d.page35.civ@army.mil

DURABILITY TEST LABORATORY (DTL)

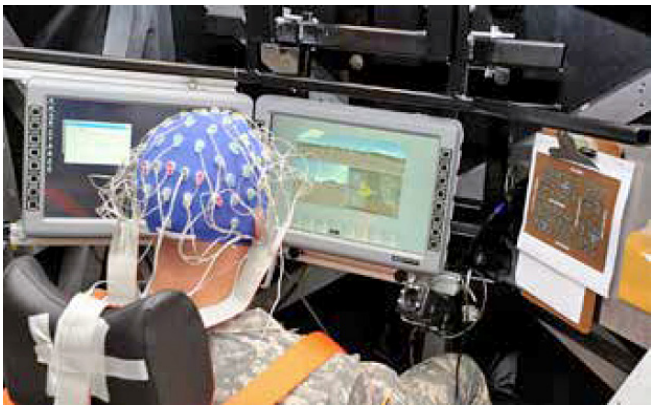
RIDE MOTION SIMULATOR (RMS)

OVERVIEW

- Single occupant reconfigurable cab
- Designed for crew station and soldier-in-the-loop virtual experimentation
- Capability to test new seating for current systems
- Hexapod configuration (Stewart Platform)
- 6 Degrees of Freedom (6-DOF: Lat, Long, Vertical (Heave), Roll, Pitch and Yaw
- Hydraulically Actuated
- Replicates the “ride” of military ground systems over several terrain types, including field collected data or analytical models
- Human in the loop real-time vehicle dynamics
- Human Safety Rated, commissioned in 1997

RMS Performance Specs	
Maximum Payload	1500lb
Acceleration Bandwidth	40 Hz
Axes Displacement	
• Linear (long, lat, vert)	±0.5m
• Angular	±20°
Max Accel w/ Max Payload	
• Linear	2g
• Angular	20 rad/sec^2
Accuracy	
• Linear	> 97%
• Angular	> 97%

Soldier Riding on RMS



Crew Station Mockup in RMS Cab

DURABILITY TEST LABORATORY (DTL)

TRAILER SHAKER, PINTLE MOTION BASED SIMULATOR (PMBS)

This piece of testing equipment can test trailers within a lab environment. It is capable of replicating loads and inputs that simulate connection to a towing vehicle.

CAPABILITIES

This test rig is used to conduct durability and performance tests on trailers. It provides motion and force inputs to the test trailer's tires and lunette to reproduce dynamic conditions in a representative driving environment. It can input most loads seen while exercising to the vehicle Op Mode Summary on Army Test Courses.

BENEFITS

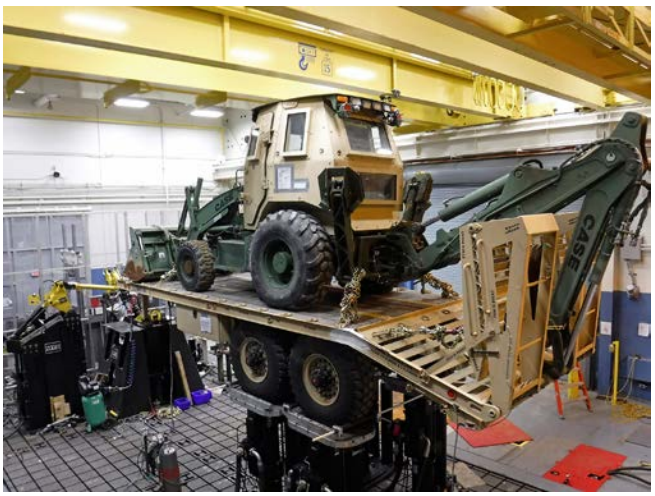
Laboratory trailer testing offers the repeatability of dynamic events, and can eliminate performance variables such as weather conditions, driver variability and course maintenance.

RIG STATISTICS

- Axial Displacement
  - Lunette
  - Vertical = ± 8 in
  - Lateral = ± 5 in
  - Longitudinal = ± 5 in
  - Tires-Vertical: = ± 10 in

- Forces
  - Lunette
  - Vertical = ± 18,000 lbs
  - Lateral = ± 11,700 lbs
  - Longitudinal = ± 27,300 lbs
  - Tires-Vertical: = ± 25,000 lbs

- Maximum Payload = 20,000 lbs



PMBS with test trailer and mission payload

PMBS with test trailer and mission payload

POC
Robert Page
robert.d.page35.civ@army.mil

DURABILITY TEST LABORATORY (DTL)

UNIAXIAL TENSION/COMPRESSION TESTERS

The DTL houses a hydraulic Instron Universal testing machine and an electric screw driven Riehle machine both capable of performing static and dynamic testing, including tensile, compression, bend, peel, tear, shear, friction, puncture, fatigue and other mechanical tests .

CAPABILITIES

- Accepts all forms of coupons or subcomponents
- Conducts low velocity and high force tests
- Used for development of Material Characterization Data

BENEFITS

Laboratory testing offers the repeatability of dynamic events, and can eliminate performance variables such as weather conditions, driver variability and course maintenance.

RIG STATISTICS

- Instron Statistics
  - Force Rating: 115,000 lb
  - Dynamic Displacement: 10 in
  - Velocity: 1118 in/min (0.5 m/s)
  - Dynamic Stiffness
  - Storage Stiffness
  - Loss Stiffness
  - Phase
  - Dampening
  - Tan Delta

- Riehle Statistics
  - Force Rating: 300,000 lb
  - Dynamic Displacement: 48 in
  - Velocity: 0.5 in/min (0.0002 m/s)
  - Force versus Displacement Characteristics
  - Force versus Velocity Characteristics
  - Peak Force versus Peak Velocity Characteristics
  - Ultimate Strength Testing
  - Durability Testing
  - Material Properties

POC
Robert Page
robert.d.page35.civ@army.mil

Instron Load Frame

Riehle Load Frame

DURABILITY TEST LABORATORY (DTL)

VEHICLE INERTIAL PROPERTIES EVALUATION RIG (VIPER)

This system is used to accurately measure system and subsystem inertial characteristics and center of gravity (CG) for vehicles, trailers, and turrets. These measured parameters include mass moments of inertia in roll, pitch, and yaw, as well as roll/yaw mass product of inertia.

CAPABILITIES

The VIPER is capable of testing almost all of the Army's wheeled ground systems and some of its tracked ground systems as well. The rig can also test other objects such as turrets, and shipping containers. The only limitation is size and weight.

BENEFITS

The mass property measurements made are an essential component for developing realistic dynamics models when solid modeling is not an option due to cost or availability. This information directly impacts vehicle design trade-off, rollover analysis/prediction, vehicle stability/handling/ride, turret drive/control, transportability assessments, suspension tuning/ design, and vehicle data plate information and analysis.

RIG STATISTICS

- Vehicle Width: up to 150 in
- Vehicle Length: up to 600 in
- Vehicle Weight: 3,000 to 100,000 lbs

Empty VIPER Test Rig

HET Under Test

Abrams Turret in Stand

POC
Robert Page
robert.d.page35.civ@army.mil

DURABILITY TEST LABORATORY (DTL)

VEHICLE SUSPENSION DYNAMOMETER

This test system is used to test components at high velocity. The intended purpose of the rig is to test suspension components like springs and shocks, but via a head expander mounted to the actuator head other components can be tested as well. The large displacement and force rating allows for testing of any of the military suspension shocks or springs currently in use. The rig is also capable of testing anything smaller such as industry components for baselining, comparison, or customer research.

CAPABILITIES

The test rig is referred to as the Suspension Test Evaluation Machine (STEM). The rig is capable of characterizing and conducting durability testing of vehicle dampers and springs, as well as quarter suspension systems from wheeled vehicles. It accepts all forms of dampener systems in use on Army ground vehicles today and from commercial vendors. It is capable of high velocity and can simulate impact and shock events in line with MIL-STD 810. Utilizing a head expander, the rig can perform tests on a wide range of test items and systems.

BENEFITS

The damper dynamometer can test components faster with less financial and logistical burden than placing the component on a vehicle and running a full vehicle test. Testing on this rig is especially advantageous where large sample sizes, iterative component design changes, or comparative design analyses are needed.

RIG STATISTICS

- Force Rating: 42,000 lbf
- Max Displacement: +/- 7 in
- Max Velocity: 300 in/s
- Max Test item Dimensions: 29.75 x 80 in
- Head Expander Size: 28.5 x 28.5 in
- Damping Coefficients
- Component Fatigue Testing
- Damper Performance Characterization
- Quarter Car Testing
- Seat Shock Characterization
- Armor Shock Characterization
- Blast Mat Characterization

STEM with JLTV Shock Absorber Front Sub- Assembly

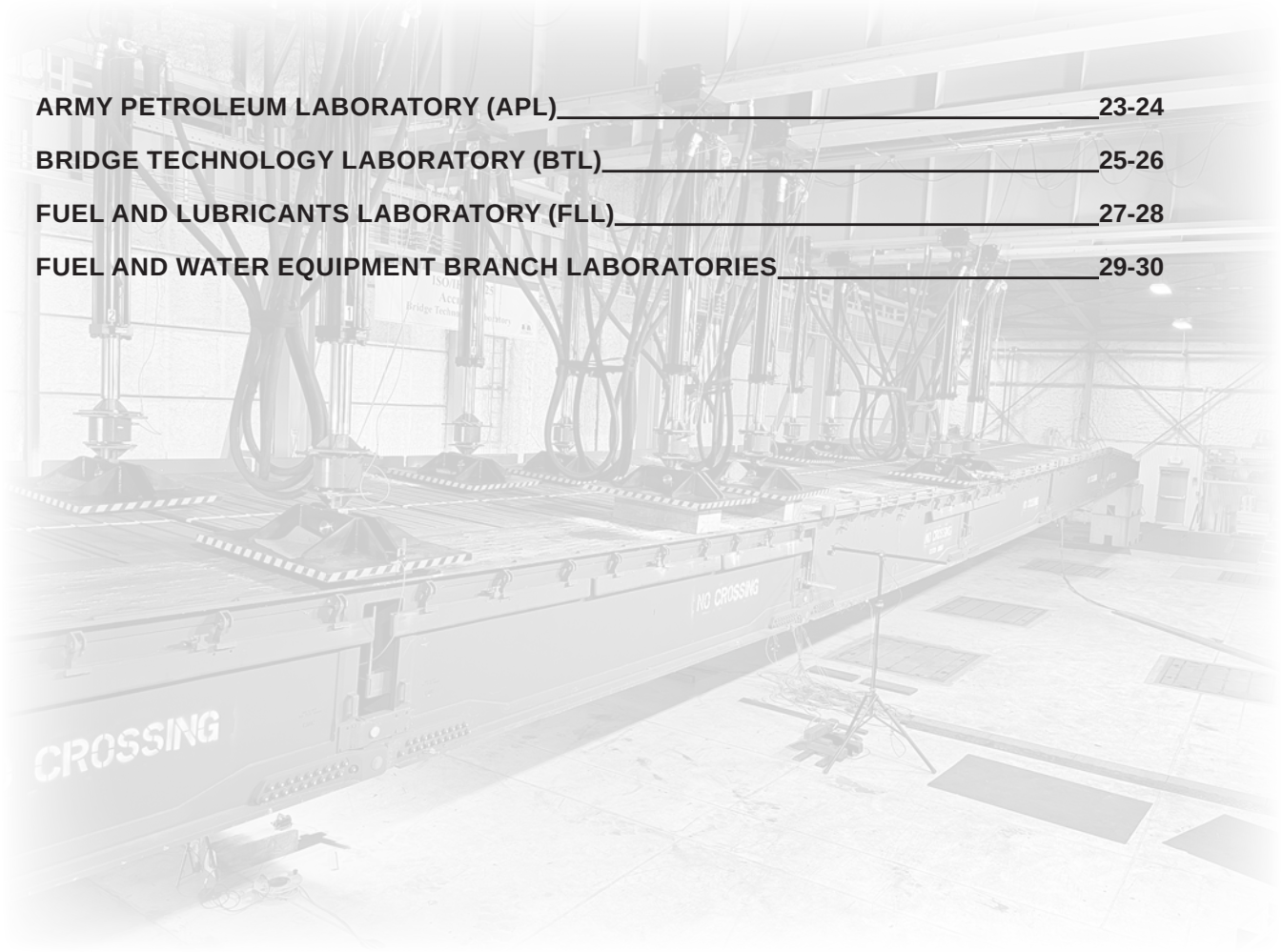
STEM with Bradley Strut

Empty Load Frame

POC
Robert Page
robert.d.page35.civ@army.mil

FORCE PROJECTION TECHNOLOGY (FPT)

Force Projection Technology provides mission lifecycle engineering for Army Combat Support and Combat Service Support equipment for gap crossing, petroleum & water systems, combat engineering, material handling, and fluid and petroleum quality surveillance. Its laboratories facilitate research, development, and engineering services to support fuels, fluids, water, wastewater and military bridging systems to keep the US Army in motion anytime, anywhere.



ARMY PETROLEUM LABORATORY (APL)

The Army Petroleum Laboratory (APL) is a tenant organization at the Defense Depot Susquehanna. APL provides quality surveillance testing of bulk fuels including jet fuel, aviation (AV) gas, automotive gasoline, diesel fuel, burner fuel, kerosene, E-85 and bio-diesels in accordance with Military Standard (MIL-STD) 3004. APL is DOD certified to extend the shelf life of packaged petroleum products and chemicals. The lab also conducts first-article testing on products such as lubricating oils and greases, hydraulic fluids, brake fluids, gear oils, engine coolants and select chemicals.

APL tests approximately 10,000 petroleum samples for the military, in addition to over 18,000 tests for over 500 customers, including aviation and ground customers, CONUS and OCONUS.

PURPOSE

Provide efficient quality surveillance of U.S. government-owned petroleum products worldwide and quality customer support to all our customers.

TECHNICAL AUTHORITY

- Responsible for quality surveillance testing mission for Army petroleum products per AR710-2 and DA-PAM-710-2
- Laboratory certified by the DOD Shelf Life Program to test package POL. Certified to test multiple Petroleum, Oil and Lubricant items in Federal Supply classes 9150/6850/6810
- Only Army fuel laboratory capable to test at a full B-2 level of testing, which is required to ensure the product is not deteriorating due to age, environmental or storage conditions

BENEFITS

- Quick testing turnaround
- Cost-effective, continuous tests
- Skilled lab associates operating equipment
- Single-point testing to easily send samples
- Test results are maintained electronicallyArmor

TESTING CATEGORIES

- Quality Surveillance of bulk petroleum products/fuels
  - Includes performing filter effectiveness tests to check filter separators efficiency on Army-owned equipment
  - Petroleum Shelf Life Extension for DOD-Owned packaged products:
  - Installation owned and war reserve product
  - Random testing on manufacturers first lot runs
  - Petroleum Shelf Life Extension
- Filter Effectiveness Testing
- Tests recycled engine coolants received from various army activities to ensure that they meet specifications.

Filter Effectiveness Testing

Bulk Petroleum Testing

Continued on next page...

QUALITY SURVEILLANCE PROGRAM

- Ensures quality of the product supplied from commercial sources to the Army activities and the Army National Guard
- Maintains quality of Army-owned petroleum products used in equipment such as tanks, trucks, HMMWVs, MRAPS, tactical and non-tactical, equipment, etc.
- Tests fuel associated with aviation crashes
- Supports laboratory certification and correlation programs of fixed and deployable Army petroleum laboratories
- Analyzes products for new Environmental Protection Agency (EPA) requirements
- Evaluates the day-to-day operational issues associated with POL products

ISO 17025 Accreditation

Accredited to perform 46 ASTM test methods on fuel and packaged petroleum products Filter Effectiveness Testing Bulk Petroleum

Fuels Laboratory

The Army Petroleum Laboratory maintains unique capabilities within GVSC's Force Projection Technology team, whose mission is to provide equipment lifecycle engineering support for the missions of gap crossing, petroleum and water systems, combat engineering, material handling and fluid quality surveillance.

BRIDGE TECHNOLOGY LABORATORY (BTL)

GVSC's Bridge Technology Laboratory (BTL) is located at Selfridge Air National Guard Base (SANGB), Harrison Township, Mich. The lab is designed to conduct strength and durability testing of military bridges, can evaluate bridging/structural components, subassemblies and complete systems in simulated environments. The lab also offers unobstructed access to test fixtures within the building and storage of large bridge components outside of the building when not being tested.

PURPOSE

To provide superior engineering support and innovative technical advancements to the warfighter across the life cycle of military bridging systems.

VISION

To be the premier bridging technology innovators for the U.S. Armed Forces.

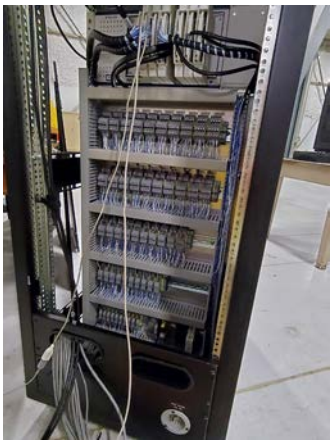
BACKGROUND

The BTL can support testing for complete bridges or structures up to 210' long, 32' wide and 23' high. The lab contains 10 hydraulic actuators to simulate vehicle crossings and loads up to 1 million pounds in a safe and controlled environment. Dedicated data acquisition equipment is also available to measure and record relevant information during tests.

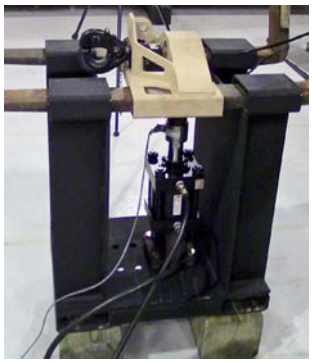
The BTL provides Military Load Classification (MLC) ratings to designate the minimum safe reserve capacity of bridges. The MLC rating is conducted in accordance with international agreements:

- Trilateral Design and Test Code for Military Bridging and Gap-Crossing Equipment
- North Atlantic Treaty Organization (NATO) Standardization Agreement, STANAG 2021

Assault Bridge Under Test



High Speed Feedback Controller



Material Handing Equipment Device Load Test

ISO 17025 Accreditation

- Accredited to perform Structural Strength and Durability Testing
- Loads up to 1 million lbs.
- Displacement up to 50"
- Dimensional outside diameter up to 6" and inside diameter between 0.7" - 6"

Continued on next page...

FUNCTIONAL & SAFETY FEATURES

- Maximum structure size: 210'L x 32'W x 23'H
- Safety windows allow live testing observation from control room, which also provides multi-camera views throughout test site
- Emergency stops
- Adaptable, stable load footprint
- Large access door enables:
  - Structures to extend outside
  - Easy access for handling equipment
  - Larger structures to be constructed outside before moving inside
- Material handling equipment includes forklifts capable of 30,000 lbs
- Man lift capable of lifting up to 475 lbs., with a maximum height of 42'
- Some limited fabrication (mill, lathe, welder, etc.) available onsite

Tactical Bridge Under Test

LOAD CONTROL SYSTEM

- 10 Computer-Controlled Hydraulic Cylinders
  - 72" Stroke
  - 100,000 lbs. each
- Deflection Safety Limits
- Lateral Safety Limit Switches
- 2,500 PSI Pressure, 100 gallons per minute (gpm) flow

DATA ACQUISITION SYSTEM

- 120 Channels
- Strain Gages
- Displacement – Lasers, Linear Variable Differential Transformers (LVDTs)
- Thermocouples
- Inclinometers

The Bridge Technology Laboratory maintains unique capabilities within GVSC's Force Projection Technology team, whose mission is to provide equipment lifecycle engineering support for the missions of gap crossing, petroleum and water systems, combat engineering, material handling and fluid quality surveillance.

FUELS & LUBRICANTS LABORATORY (FLL)

GVSC Fuels and Lubricants (F&L) Branch operates and maintains the Fuels and Lubricants Laboratory (FLL). The FLL has the ability to conduct research, development, testing, analysis, and investigation of Army ground system fuels, lubricants, and fluids. Laboratory experts adhere to standardized testing methodology as published by ASTM International, SAE International, and Federal Test Method 791.

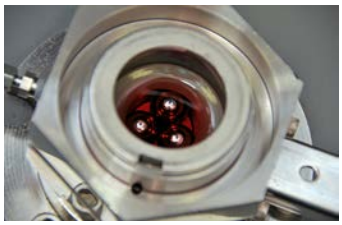
MISSION

Fuel. Cool. Lubricate.

VISION

To modernize military mobility with fuel, lubricant, & thermal management technologies.

Qualification



Research & Investigation

F&L serves as the Department of Defense's responsible agent for all ground fuels and lubricants specifications: AR70-12 – Fuels and Lubricants Standardization Policy for Equipment Design, Operation, and Logistic Support.

GVSC's Fuels and Lubricants Laboratory comprises 7,075 square feet with an additional 1,600 square feet of space for Petroleum, Oil and Lubricants (POL) storage. FLL's capabilities span from specification and qualification testing, to investigation of field failures or hardware issues, and experimental research in tribology, nanotechnology, corrosion, and fuel efficiency improvement of products. Testing capabilities cover necessary powertrain products for ground vehicles and equipment, including coolants, hydraulic fluids, and other fluids & solvents.

CAPABILITIES

- Combustion and Volatility
- Physical Properties
- Elemental Properties
- Stability and Cleanliness
- Flow/Rheology
- Tribology
- Elastomer Compatibility
- Corrosion Prevention
- Chemical reaction/interface modeling and simulation

BENEFITS

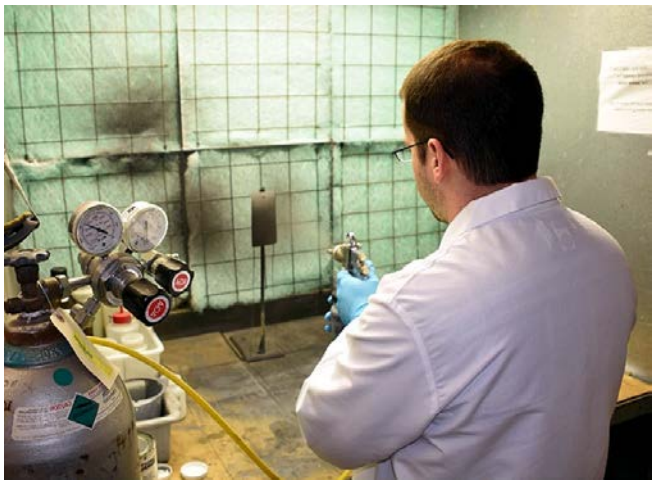
- Independent government analysis, testing and interpretation of results
- Government and industry interface
- Prompt testing supports in-house GVSC projects, especially in conjunction with GVPM testing
- Historical background on products
- Development of custom products and associated specifications and documentation for procurement
- Hardware evaluations consist of utilizing physical and optical profilometry techniques to perform materials, tribofilm, and failure analysis on a wide variety of vehicle parts
- Expertise to modernize Army lubricants while remaining cognizant of the impact to the supply chain
- Leverage industry partners to identify critical new technologies for the Army such as electric vehicle thermal management fluids and lubricants
- Achieving technical authority in basic research related to computational and experimental methodologies

F&L Chemical Engineer examining particulate contamination in fuel.

Continued on next page...

FORCE PROJECTION TECHNOLOGY (FPT)

The GVSC Fuels and Lubricants Branch maintains the government owned, contractor operated research facility in San Antonio, TX. The GVSC Fuels and Lubricants Research Facility (GFLRF) provides research, development, and engineering services via component rig & engine testing and analytical chemistry.



F&L Research Engineer preparing steel panels for solid film lubricant testing.

CAPABILITIES

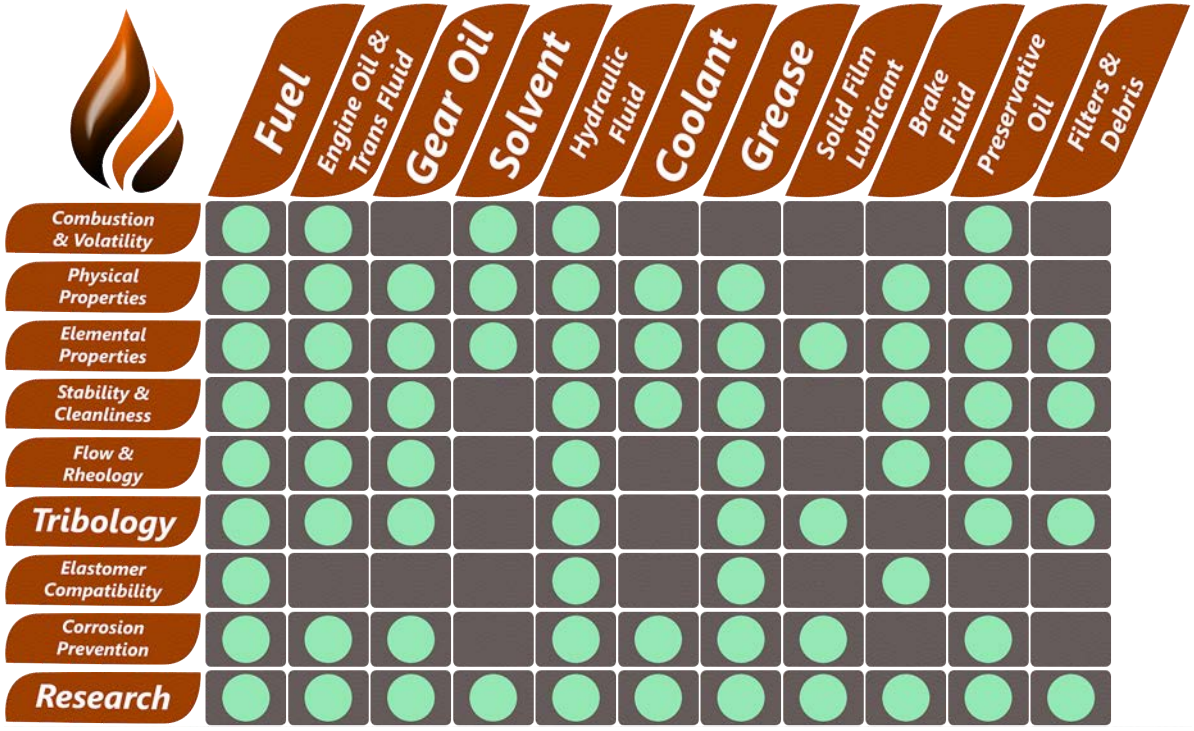
- Fuel Bladder Testing
- Light-Duty Vehicle Emissions Testing
- Heavy-Duty Vehicle Chassis Testing
- Mileage Accumulation Dynamometers
- Engine Dynamometer Cold Testing
- Temperature-Controlled Vehicle Testing Chambers
- Temperature-Controlled Emissions Enclosure, On-Site Test Track
- Analytical Fuel Analysis Laboratory

The F&L Laboratory maintains unique capabilities within the GVSC's Force Projection Technology team, whose mission is to provide equipment lifecycle engineering support for the missions of gap crossing, petroleum and water systems, combat engineering, material handling and fluid quality surveillance.

ISO 17025 Accreditation

Accredited to perform 31 ASTM test methods on fuel and oil

F&L Products & Capabilities



FUEL AND WATER EQUIPMENT BRANCH LABORATORIES

Water Research Laboratory (WRL) and Water Treatment Test Facility (WTTF) in southeast Michigan provide water and wastewater related products and technical services that capitalize on emerging technologies ensuring the best possible products are available to the Soldier to perform their current and future missions. These facilities provide GVSC Fuel and Water Equipment Branch (FWEB) with the ability to test and evaluate water and wastewater treatment, storage and distribution, and quality analysis technologies from bench-scale to full-scale and at the component to the integrated system levels.

PURPOSE

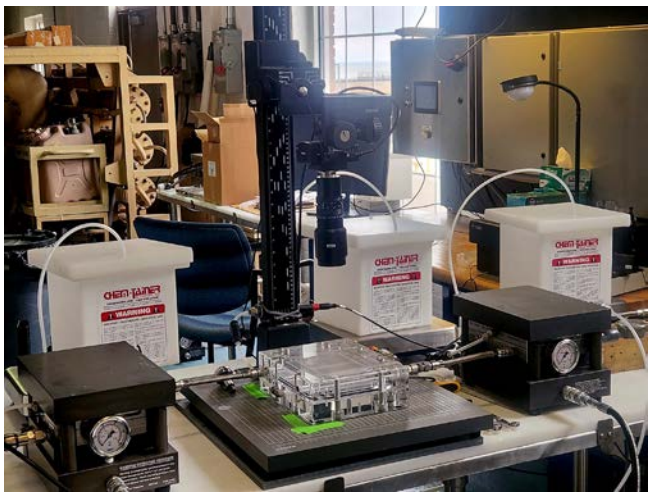
Provides research, development and engineering services for the Army's tactical equipment engaged in water and wastewater treatment and the storage, distribution and quality analysis of water on the battlefield.

In addition to researching emerging technologies, the WRL conducts military-specific water treatment testing which resolves field issues, and evaluates new components and methods. In addition, the WTTF provides a relevant environment to test water treatment and handling solutions in order to evaluate equipment, from small components to large integrated systems.

GVSC has access to the Seawater Desalination Test Facility, located at and operated by the Naval Facilities Expeditionary Warfare Center (NAVFAC EXWC), Port Hueneme, Calif. Facility capabilities are comparable to the WTTF facilities but use natural seawater as the test water.

CAPABILITIES INCLUDE

- Water purification equipment testing from bench-scale and individual components to large, integrated systems
- Water packaging and handling equipment testing
- Water quality analysis equipment testing
- Membrane testing: Reverse Osmosis (RO), Nanofiltration, Ultrafiltration, Microfiltration
- Greywater re-use technology testing



RO Membrane Swatch Test Stand

Small Unit Water Purifier

Reverse Osmosis (RO)

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FORCE PROJECTION TECHNOLOGY (FPT)

BENEFITS

- Facility provides a year-round, relevant test environment
- Direct access to a large, natural fresh water source
- Ability to prepare large volumes of simulated source waters: NSF 350 greywater, seawater, etc.
- Staff experienced in water/wastewater treatment technologies and systems:
  - Design
  - Operation
  - Maintenance
  - Testing
  - Training

FEATURES AND EQUIPMENT

- Heated indoor boat well which allows year-round operation on a natural fresh water source
- National Pollutant Discharge Elimination System (NPDES) permit for discharge of up to 500,000 gallons per day
- Military Water Purification Equipment includes:
  - Lightweight Water Purifier (LWP)
  - 600 GPH Reverse Osmosis Water Purification Unit (ROWPU)
  - 1500 GPH Tactical Water Purification System (TWPS)
  - 3000 GPH ROWPU
- Test skids for RO and Pretreatment evaluations
- Water Quality Analysis
  - Analytical Lab
  - Access to EPA certified, water quality analysis laboratory
  - In-line instrumentation, e.g., flow meters, pressure gauges, turbidity & conductivity meters
- Facilities for large systems
  - Material Handling equipment to include 4K and 10K fork lifts
  - Compressed Air: 140 psi, -65 °F dew point
  - Electrical
    - 125 kVA multi-tap transformers deliver 440/460/480V 3 phase power
    - Multiple 208V single and 3-phase power disconnects
  - Exterior concrete pad at water's edge
  - Conference room seating for up to 25

Lake St. Clair Provides Natural Fresh Water

Water Quality Test Lab

The Fuel and Water Equipment Branch Laboratories maintain unique capabilities within GVSC's Force Projection Technology business area, whose mission is to provide lifecycle engineering support for the missions of gap crossing, petroleum and water systems, combat engineering, material handling and fluid quality surveillance.

FUEL CELL LABORATORY

The Fuel Cell Laboratory (FCL) is part of GVSC and located in the GSPEL building. This lab mainly supports the Fuel Cell Technologies Branch as part of GVPM but also supports other DOD, DOE, and commercial efforts. Lab focus is on various research, development, integration, and testing of both hydrogen and JP-8 based fuel cell projects and has a flexible working space layout to accommodate and enable this work.

OVERVIEW

The Fuel Cell Laboratory is part of GVSC and located in the GSPEL building. This lab mainly supports the Fuel Cell Technologies Branch as part of GVPM, but also supports other DOD, DOE and commercial efforts. Lab focus is on various research, development, integration, and testing projects and has a flexible working space layout to accommodate and enable this work.

4 FUME HOODS

- Accommodate small components to full size systems
- Hydrogen, JP-8, steam, cooling water supplied to each
- Capable of up testing 500W - 50 kW in a single fume hood
- Solid Oxide Fuel Cell (SOFC) stack test capability

RESEARCH AND ANALYSIS

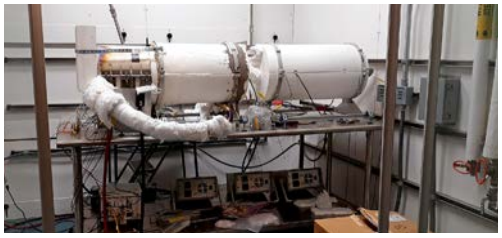
- Full chemical analysis using Gas Chromatograph / Mass Spectrometer (GC/MS)
- SOFC stack initial and sustained performance characterization using laboratory hotbox, fuel/air heaters
- Fuel cell electrode and membrane performance characterization using Electrochemical Impedance Spectroscopy (EIS)
- SOFC catalyst fuel contamination characterization
- Fuel cell surface characterization for cracking and contamination deposition using Optical Microscopy

FLEXIBLE LAB SPACE

- Vehicle and/or equipment integration space and tools
- 3D print capability for small parts
- Electrical and mechanical capabilities

Walk-In & Bench Top Fume Hoods

Large Walk-In Fume Hood



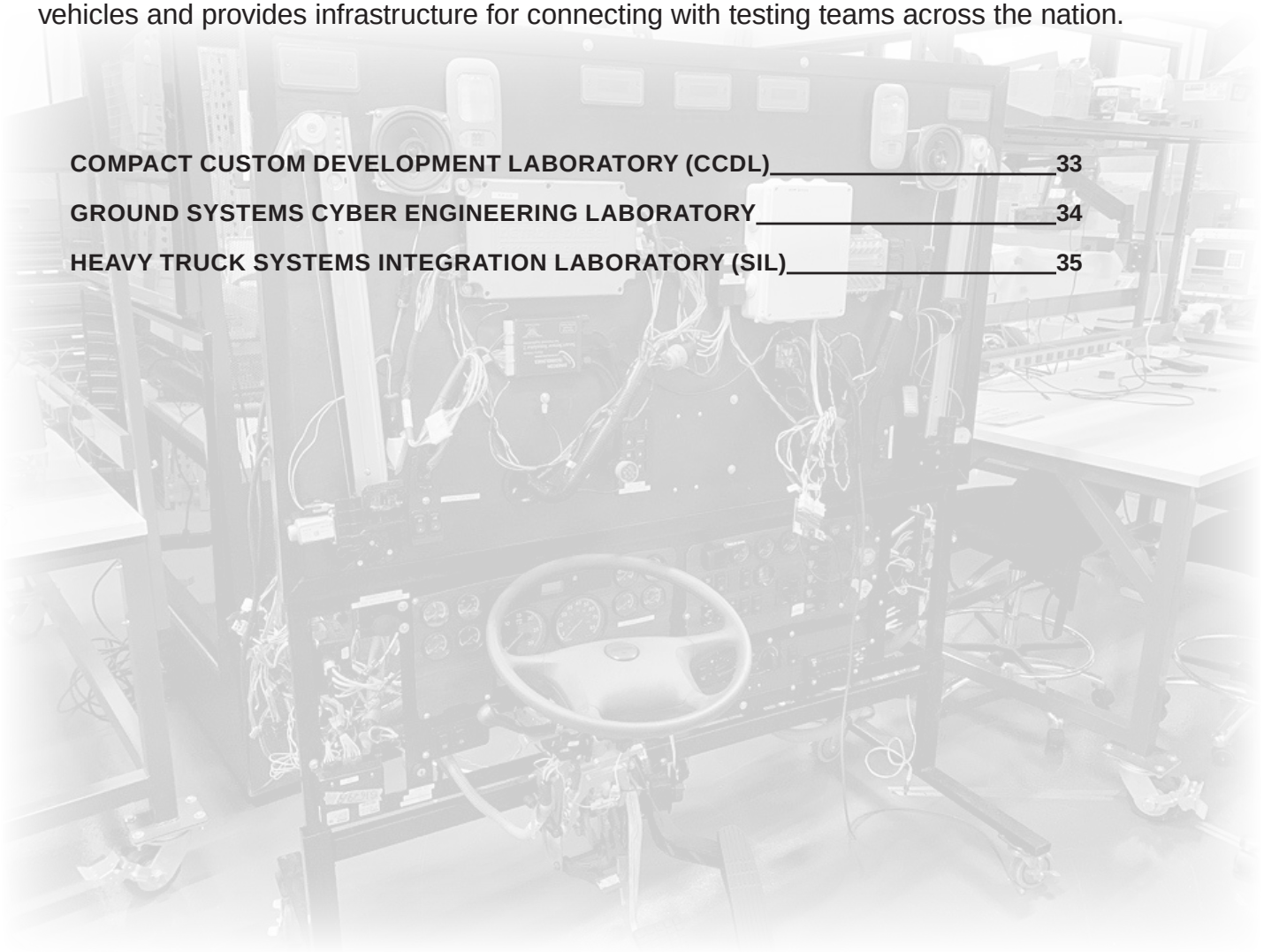
Solid Oxide Fuel Cell Stack Test Stand

Flexible Floor Space for Integration Work

Gas Chromatograph / Mass Spectrometer

GROUND SYSTEMS CYBER ENGINEERING (GSCE) LABORATORIES

The Ground Systems Cyber Engineering (GSCE) Laboratory analyzes electronic systems consisting of both hardware and software to uncover cybersecurity vulnerabilities that may be used to degrade the performance of the system in operation. The lab can perform full-spectrum vulnerability scans and cyber penetration tests to uncover previously unknown vulnerabilities and provide an independent assessment of a full vehicle system or targeted sub-systems and components. GVSC's lab provides a confidential environment capable of housing multiple large vehicles and provides infrastructure for connecting with testing teams across the nation.



GROUND SYSTEMS CYBER ENGINEERING (GSCE) LABORATORY

COMPACT CUSTOM DEVELOPMENT LABORATORY (CCDL)

Ground Systems Cyber Engineering (GSCE) Vehicle and Support Systems Cybersecurity (VS2C) engineers have the capability to develop, implement, and document procedures to produce Compact Custom Development Lab (CCDL) for military ground systems. Similar to a System Integration Lab (SIL), the CCDLs are used to support efforts which require logical or limited use of an overall systems information technology (IT) information system (IS) but on a smaller scale. The CCDL provides the potential for substantial, immediate, and long term cost savings to adopters in all applicable work efforts related to the overall system IS as the need to send assets, both personnel and equipment/vehicles, are drastically reduced.

Sample Compact Custom Development Lab

The service provided ensures the CCDL is a holistic package wherein everything required to construct, deploy and complete required related tasks is included in one portable kit.

Typical use cases would be systems and networks capable of being virtualized, or standalone systems that cannot efficiently be virtualized (ARM/embedded systems) that also do not require the complexity and cost incurred with use of a traditional SIL.

CAPABILITIES

- Requirements/capability analysis
- Hardware and software system design
- Holistic planning and procedure authoring

AVAILABLE SYSTEM DEPLOYMENTS

- FMTV A2 Variant Greyhill Drivers Display Unit Vulnerability scan and system shell level access provided

POC
Jonathan Tarlo
jonathan.m.tarlo.civ@army.mil

GROUND SYSTEMS CYBER ENGINEERING (GSCE) LABORATORY

GROUND SYSTEMS CYBER ENGINEERING LABORATORY (GSCE)

The GVSC Ground Systems Cyber Engineering Lab capability produces information about the cybersecurity risks inherent in ground vehicle systems. This information is used to prioritize resources to address readiness, security, and financial risks from cyberattack.

The Ground Systems Cyber Engineering Lab analyzes electronic systems consisting of both hardware and software to uncover cybersecurity vulnerabilities that may be used to degrade the performance of the system in operation. The lab can perform full-spectrum vulnerability scans and cyber penetration tests to uncover previously unknown vulnerabilities and provide an independent assessment of a full vehicle system or targeted sub-systems and components. GVSC's lab provides a confidential environment capable of housing multiple large vehicles and provides infrastructure for connecting with testing teams across the nation.

The GSCE Lab also provides Cyber Reconnaissance Services which focus on periodic and scheduled vulnerability assessment of program systems using a variety of cyber assessment tools. Recurring assessment scans evaluate potential vulnerabilities and weak configurations that will create compliance issues. Schedules and deliverables can be tailored to a partner's program needs or for the needs of a specific point in an accreditation or testing process.

CAPABILITIES

- Vulnerability discovery
- Cyber effects on vehicle dynamics
- Input validation and fuzzing
- Data anthropology
- Electronics reverse engineering
- Wired and wireless network protocol analysis
- Static and dynamic software analysis
- Assured Compliance Assessment Solution (ASAS) scanning

CYBER RECONNAISSANCE SERVICES

- Program / system vulnerability assessment with a variety of tool options
- Controlled assessment environment
- Detailed reports with all findings provided in a timely fashion and on schedule per mission partner agreement
- Flexible options for custom tailored solutions
- All assessments, reports, and procedures are DoD, DISA compliant

M113 Inside RF Shielded Enclosure

POC
Joe Gothamy
joseph.o.Gothamy.civ@army.mil

GROUND SYSTEMS CYBER ENGINEERING (GSCE) LABORATORY

HEAVY TRUCK SYSTEMS INTEGRATION LABORATORY (SIL)

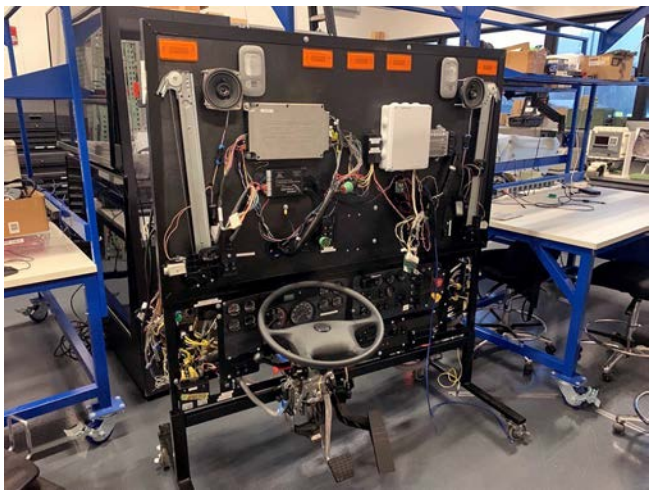
The Heavy Truck Systems Integration Lab (SIL) is a full electronic replication of a heavy truck, which is used to test and validate cyber intrusion detection technology. The Heavy Truck SIL provides a testbed for heavy truck cyber resilience technologies.

CAPABILITIES

- Heavy Truck modeled after M915
- Engine and Transmission simulation
- Full vehicle electronic setup

AVAILABLE INSTRUMENTATION

- Vehicle Spy
- PEAK PCAN USB interface
- Signal generator for engine sensor simulation

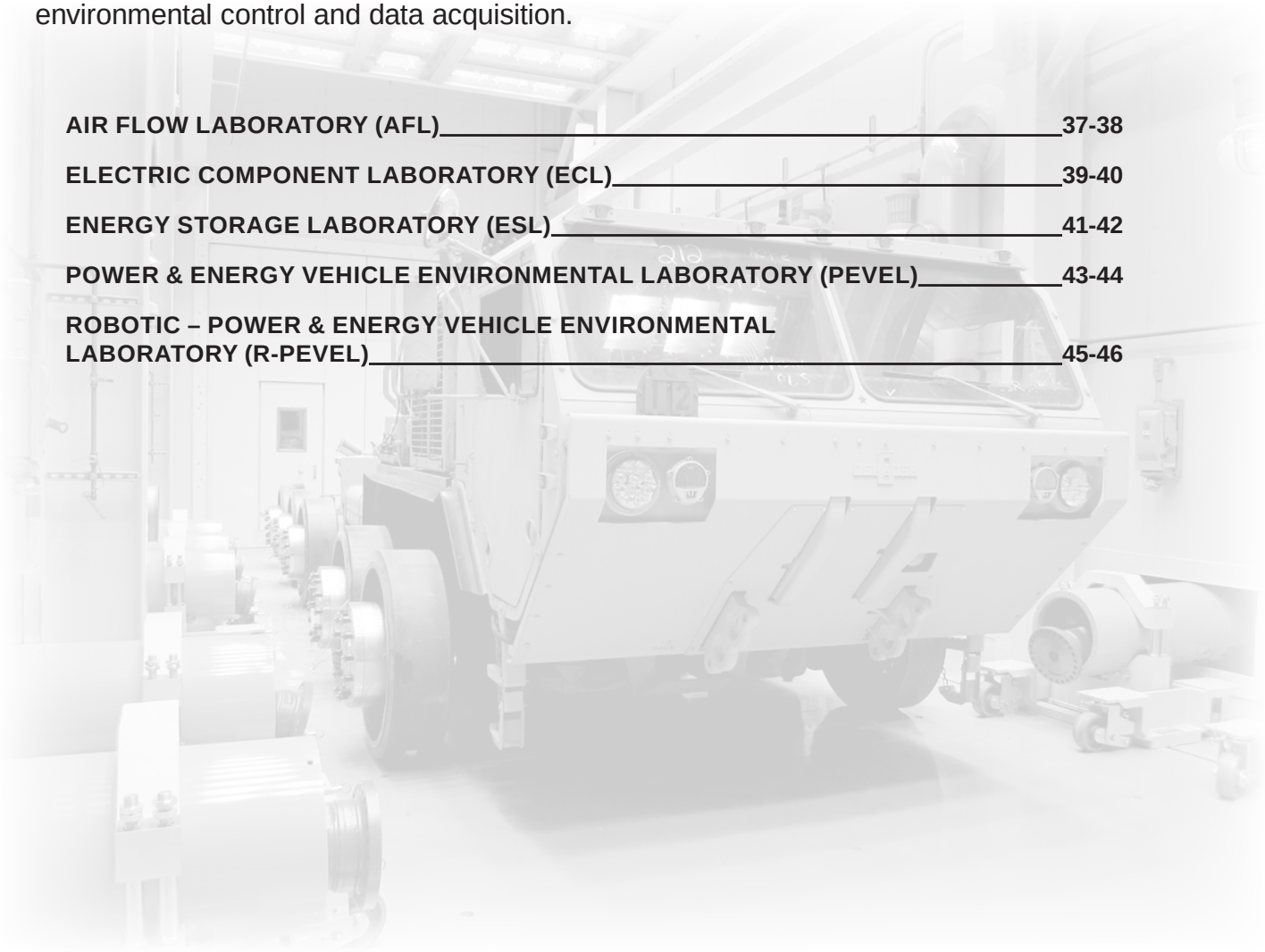


Heavy Truck SIL

POC
Dan Newport
daniel.w.newport.civ@army.mil

GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

GVSC's Ground Systems Power and Energy Laboratory (GSPEL) is the Army Centerpiece for mobility, power and energy R&D, integration, and testing of current and emerging ground vehicles, providing enhanced capabilities for delivering the best, most advanced ground vehicle technology to our warfighters. It is a centralized, integrated, one-of-a-kind facility to provide steady-state and transient (mission profile) test capability with state-of-the-art test parameter/ environmental control and data acquisition.



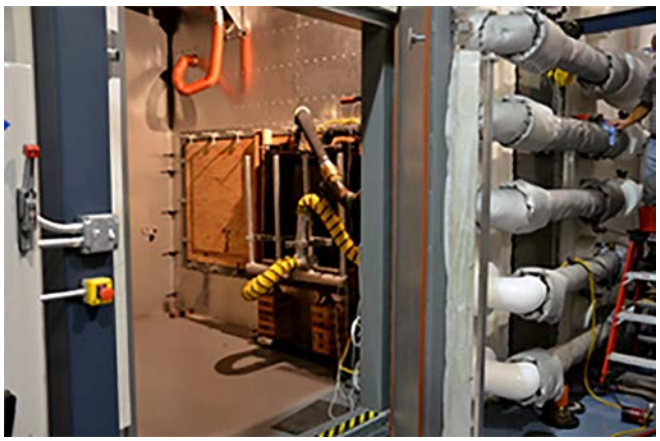
GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

AIR FLOW LABORATORY (AFL)

GVSC's Ground Systems Power and Energy Laboratory (GSPEL) Team operates the Air Flow Laboratory (AFL) which supports the execution of component level testing on several critical mobility systems on a variety of military vehicles by use of Calorimeter and Air Filtration Testing.

CALORIMETER TESTING BENEFITS

- Evaluate new heat exchangers and ballistic grilles
- Repeatable simulate field environmental conditions
- Test up to three heat exchangers as a pack
- Unique Army testing capability
- Unbiased first-article test and production quality



AFL Calorimeter Test

FILTRATION TESTING BENEFITS

- Evaluate new air cleaner systems
- Replicate field failures
- Assess impact of add-on parts to air cleaner system
- Assess maintenance efficiency
- Unique Army testing capability
- Unbiased first-article test and production quality surveillance

AFL Filtration Test

COMPONENTS TESTED

- Air cleaner systems
- Add-on components to air cleaner system

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GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

CAPABILITIES

GVSC's Ground Systems Power and Energy Laboratory (GSPEL) Team operates the Air Flow Laboratory (AFL) which supports the execution of component level testing on several critical mobility systems on a variety of military vehicles by use of Calorimeter and Air Filtration Testing.

CALORIMETER CAPABILITIES

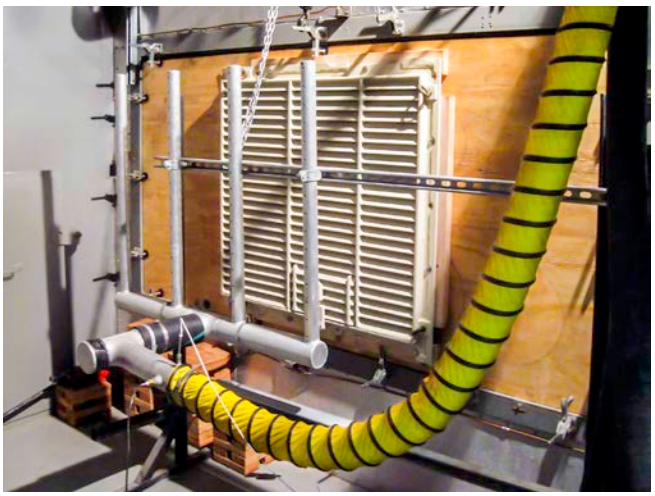
- Cooling Air
  - Air Flow Rate: 800 to 60000 CFM
  - Air Flow Velocity: 3000 to 7000 ft/min
  - Inlet Air Temperatures: up to 250 °F
- Radiator Loop
  - Coolant Flow Rate: 10 to 300 gal/min
  - Coolant Inlet Temperature: 125 to 350 °F
  - Coolant Inlet Pressure: 0 to 125 psig
- Oil Cooler Loop
  - Oil Flow Rate: 10 to 150 gal/min
  - Oil Inlet Temperature: 175 to 350 °F
  - Oil Inlet Pressure: 0 to 300 psig
- Charge Air Cooler Loop
  - Charge Air Flow Rate: 30 to 150 lb/min
  - Charge Air Temperature: 150 to 650 °F
  - Charge Air Inlet Pressure: 15 to 90 psig

AIR FILTRATION CAPABILITIES

Ambient air conditions are controlled in the Air Filtration laboratory. In addition to controlling temperature, the relative humidity can be set to the desired level.

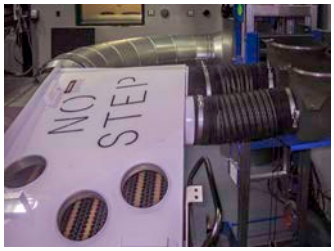
- 250 CFM Bench
  - Air Flow Rate: 8 to 250 SCFM
- 2000 CFM Bench
  - Air Flow Rate: 80 to 2000 SCFM
- 5000 CFM Bench
  - Air Flow Rate: 320 to 5000 SCFM
- 12000 CFM Bench
  - Air Flow Rate: 800 to 12000 SCFM

POC
Igor Baseski
igor.baseski.civ@army.mil



Radiator Test Setup

Ballistic Grille Test Setup



12,000 CFM Test Setup

2,000 CFM Test Setup

2,000 CFM Test Setup

GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

ELECTRIC COMPONENT LABORATORY (ECL)

GVSC's Ground System Power and Energy Laboratory (GSPEL) Team operates the Electric Component Laboratory (ECL) which supports research, development, characterization and testing of high-voltage, high power components necessary for military vehicle electrification and hybrid-electric technology. This lab's research extends to a testing cell in the Propulsion Laboratory that has programmable power absorption and supply capabilities with voltage, current and power, and controls a 350-horsepower AC dynamometer. Component testing on vehicle is also available. The ECL provides temperature and humidity controlled environments, as well as 346kW and 373kW AC dynamometers to fully test various components.

BENEFITS

The ECL offers several benefits:

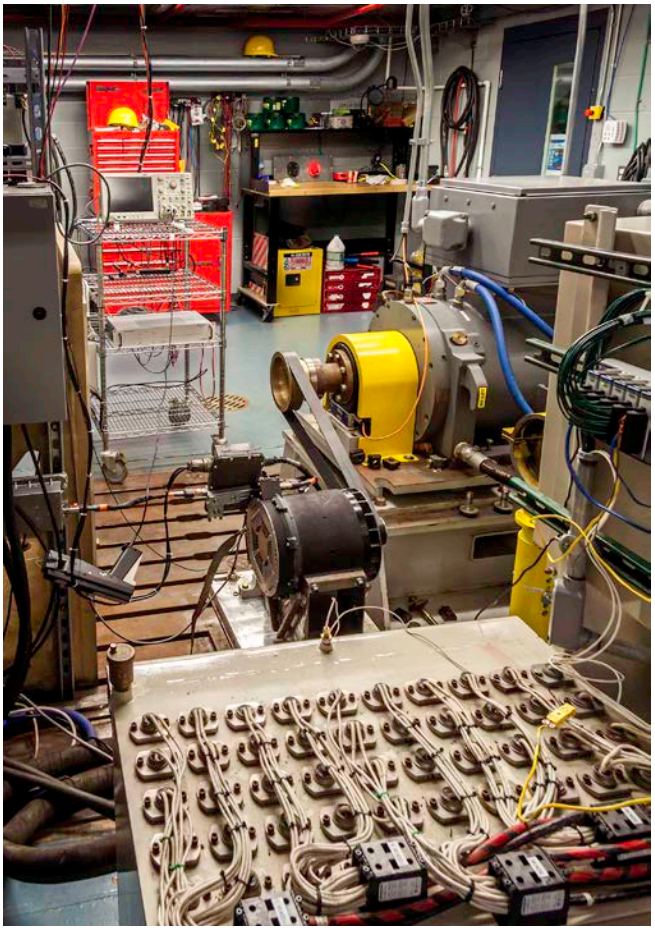
- Testing of high voltage, high power components
- Analyze future electrical power generation and control technologies for the Army
- Provides power quality, transients, and harmonic distortion
- Variable coolant temperature and flow rate over a large range
- (Future) Certified and accredited testing to ISO17025
- Thermal chamber for component level testing
- MIL-PRF-GCS600 testing
- Resistive and Capacitive load banks to simulate a wide variety of load types
- Pressure testing of coolant cooled components using high sensitivity pressure transducers

COMPONENTS TESTED

The ECL can test multiple types of components:

- Advanced Electric Machines
- High Voltage Alternators
- Motor controllers
- Power Inverters
- DC/DC Converters

G40-2B ISG



Niehoff Alternator 600VDC

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GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

CAPABILITIES

ECL Dynamometer
- 373kW 4Q AC Dynamometer
- 3,321 Nm torque from 0-1000rpm
- 0 – 12,000 rpm speed range

CELL 10 Dynamometer
- 346kW 4Q AC Dynamometer
- 1,245Nm torque from 0-2000rpm
- 0 – 12,000 rpm speed range

Thermal Chamber
- Temperature range of -30 to +177 C
- Humidity range of 10% to 95% RH, 85C Max temp and 4C minimum dewpoint
- 439 Liter capacity

AV-900 250kW Dual Power Supply
- Voltage: 8 to 900V
- Current: +/- 1000 ADC
- Power: +/- 250kW

Acquisition of mechanical and electrical parameters
- Phase to Phase measurements
- Active, apparent and reactive power
- Mechanical power
- Power factor and efficiency
- Fundamental frequency
- Total Harmonic Distortion
- Voltage & Current Transients
- Cooling characteristics; Thermal, pressure, flow rate

AC Dynamometer

Power Cycling Station

ECL & Cell 10

POC
Igor Baseski
igor.baseski.civ@army.mil

GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

ENERGY STORAGE LABORATORY (ESL)

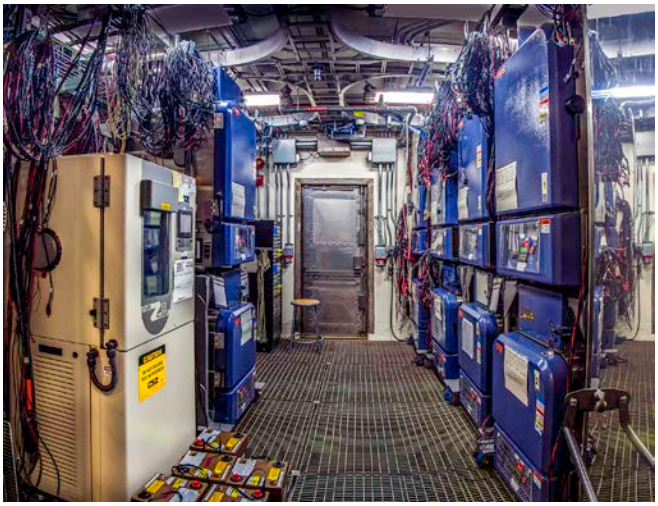
GVSC's Ground Systems Power and Energy Laboratory (GSPEL) Team operates the Energy Storage Laboratory (ESL), an ISO/IEC 17025 accredited laboratory, which supports testing and evaluation of batteries and electrochemical technologies at cell, module and battery pack level.

CAPABILITIES/FACILITIES

- Three (3) large Battery Test Rooms, two (2) Pack Test Chambers, an Electrochemical Research Lab, and a Battery Management System Lab
- Multiple cell/battery Cyclers on a centralized control system
- Thermal Chambers (1.5ft3 – 69.3ft3)

CAPABILITIES/BENEFITS

- Cradle-to-grave R&D and surveillance testing support for all DoD ground vehicle energy storage systems
  - Performance to specification
  - Cycles to Failure (Service Life)
  - Cold Cranking
- Assess TRL levels and understand new technology/chemistry
- Assess performance of fielded storage systems
- Test new solutions for fielded and future vehicle systems



Internal Cell/Module Test Room

Cell, Module & Battery Cycling Equipment

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EQUIPMENT

Battery Cyclers

Brand	Model	Quantity of units	# of Channels per unit*	# Thermocouples Channels per unit	Voltage		Current		Temperature	
					Range	Tolerance	Range	Tolerance	Range	Tolerance
Bitrode	LCV3-100-36	1	3	7	±54VDC	±.05VDC	±100ADC	±.1ADC	-40 to 190°C	±2.5°C
Bitrode	MCV48-50-5	2	48	48	±5VDC	±.005VDC	±50ADC	±.05ADC	-40 to 190°C	±2.5°C
Bitrode	LCV12-50-24	2	12	16	±32VDC	±.036VDC	±50ADC	±.05ADC	-40 to 190°C	±2.5°C
Bitrode	LCV4-100-36	1	3	8	±54VDC	±.05VDC	±100ADC	±.1ADC	-40 to 190°C	±2.5°C
Bitrode	LCV4-100-60	8	4	8	±60VDC	±.06VDC	±100ADC	±.1ADC	-40 to 190°C	±2.5°C
Bitrode	DTV1-2000-24**	1	1	1	-24VDC	±.024VDC	-2000ADC	±2.0ADC	-40 to 190°C	±2.5°C
Bitrode	LCV8-100-60	3	8	12	±60VDC	±.06VDC	±100ADC	±.1ADC	-40 to 190°C	±2.5°C
Bitrode	LCV2-1000-48	1	2	4	±72VDC	±.07VDC	±1000ADC	±1.0ADC	-40 to 190°C	±2.5°C
Aero-Vironment	AV900	3	2	-	±900VDC	±1.35VDC	±300A	±1.13ADC	-	-

*Channels within unit may be placed in parallel for higher currents
**Discharge only

Temperature Conditioners

Brand	Model	Quantity of units	Temperature		Internal Volume	Cooling Change Rate	Heating Change Rate
			Range	Tolerance			
ESPEC	BTZ-175	5	-65 to 150ºC	±.5ºC	1.5 ft^3	5°C/min	5°C/min
ESPEC	BTZ-475	20	-65 to 150ºC	±.5ºC	4 ft^3	2.5°C/min	2.75°C/min
Cincinnati Sub-Zero	ZPHS-8-1.5-1-H/AC	1	-65 to 150ºC	±.5ºC	8 ft^3	14°C/min	17°C/min
Tenney	T10RC-1.5	2	-65 to 150ºC	±.3ºC	10 ft^3	4°C/min	5.5°C/min
Russells	GD-64-5-5-AC-EP	2	-65 to 150ºC	±1ºC	64 ft^3	3°C/min	3.8°C/min
Thermotron	SE-2000-6-6	1	-65 to 150ºC	±.7ºC	69.3 ft^3	3.4°C/min	5.3°C/min
Test Equity	1007-C	1	-65 to 150ºC	±.5ºC	7 ft^3	3.3°C/min	7.3°C/min

Outdoor Pack Test Chambers

POC
Igor Baseski
igor.baseski.civ@army.mil

GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

POWER & ENERGY VEHICLE ENVIRONMENTAL LABORATORY (PEVEL)

GVSC's Ground Systems Power and Energy Laboratory (GSPEL) Team operates the Power & Energy Vehicle Environmental Laboratory (PEVEL) which enables GVSC to perform vehicle-level performance and durability testing on both wheeled and tracked vehicles. The PEVEL's reconfigurable dynamometers can support up to a 5-axle wheeled vehicle with 34,000 lbf·ft (per wheel) and tracked vehicles up to 42,000 lbf·ft (per side). The PEVEL offers controlled environmental conditions with temperatures ranging from -60 to 160 °F, humidity levels from 0 to 95 %Rh, wind speeds up to 60 mph, and solar load up to 1,200 W/m^2

PEVEL TESTING CAPABILITIES

- Transient Road-Load Profiles
- Vehicle Acceleration
- Fuel Economy
- Full-Load Cooling
- Speed on Grade
- HVAC Validation
- Engine Cold-Start Evaluation
- Alternator Load Testing

PEVEL - Test Cell Interior

Tracked Vehicle Performance Testing

Wheeled Vehicle Performance Testing

Continued on next page...

GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

TEST CHAMBER OVERVIEW

Powertrain Specifications

- Wheeled Vehicle Dynamometers
  - Speed: 0-1,000 RPM
  - Torque: 0-34,000 lbf-ft (per wheel)
  - Power: 0-160 hp (per wheel)
  - Wheel Stations: up to 10 wheels (5 axle)

- Tracked Vehicle Dynamometers
  - Speed: 0-1,250 RPM
  - Torque: 0-42,000 lbf-ft (per side)
  - Power: 0-800 hp (per side)

Environmental Control

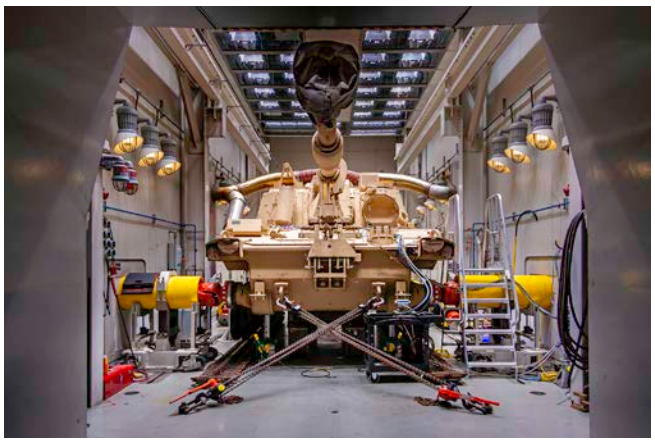
- Temperature: -60 to 160°F
- Wind: 0-60 mph
- Solar: 0-1,200 W/m2
- Humidity: up to 95% RH

General Information

- Chamber Door: 14 ft (W) x 14 ft (T)
- Dimensions: 20 ft (W) x 20 ft (T) x 75 ft (L)
- Floor Capacity: up to 100 tons
- Crane: 25 tons
- Multiple Vehicle Build-up Bays

PEVEL - JLTV (Full Load Cooling Test)

PEVEL - PLS (Transmission Calibration)



PEVEL - M109A7 (Grille Performance)

POC
Igor Baseski
igor.baseski.civ@army.mil

GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

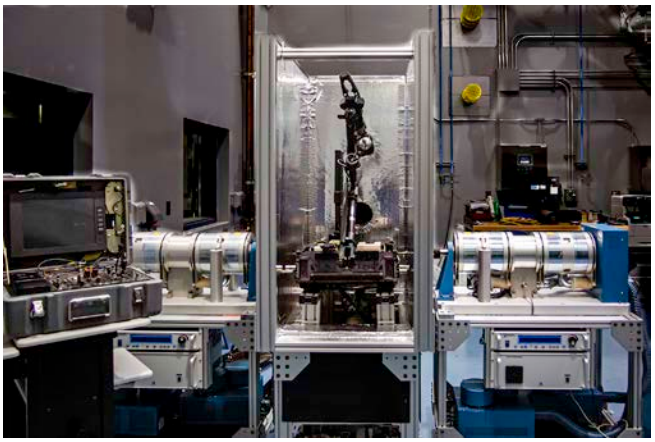
ROBOTIC - POWER ENERGY VEHICLE ENVIRONMENTAL LABORATORY (R-PEVEL)

GVSC's Ground Systems Power and Energy Laboratory (GSPEL) Team operates the Robotic - Power & Energy Vehicle Environmental Laboratory (R-PEVEL) which enables GVSC to perform robot platform-level performance and durability testing on both wheeled and tracked robotic platforms. The R-PEVEL's 2 quadrant dynamometers can support up to a Common Robotic System – Intermediate (CRS-I) sized robotic platform, and up to 56.5 Newton-Meters at up to 8,000 RPM. The R-PEVEL offers controlled environmental conditions with temperatures ranging from -60 to 160 °C.

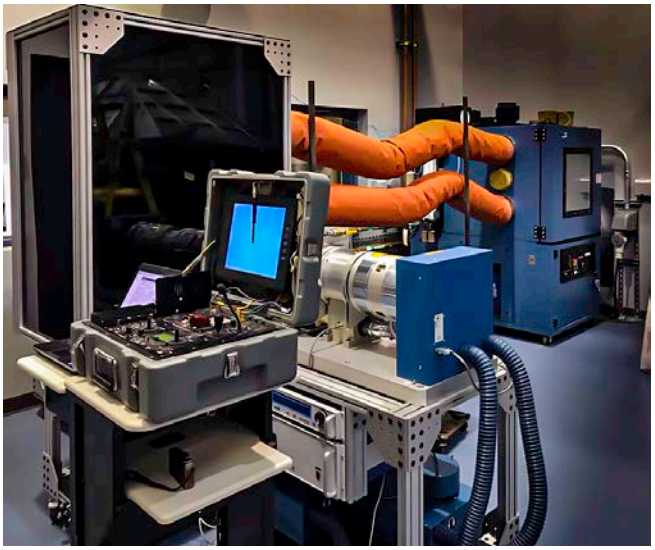
R-PEVEL TESTING CAPABILITIES

- Mobility and Performance testing of small robotic platforms
- Motors and Drives power measurement
- Performance Characteristics of low to medium power range motors
- Load simulation for duty cycle and life testing
- Testing in extreme climates under various loads
- Powertrain development and prototype system/ component evaluation

R-PEVEL System View



R-PEVEL Test Chamber View



R-PEVEL System View with Thermal

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GROUND SYSTEMS POWER AND ENERGY LABORATORY (GSPEL)

TEST CHAMBER OVERVIEW

Dynamometer Specifications

- 14 kW 2Q Hysteresis Dynamometer x2
- 56.5 Nm torque rating
- 0-8,000 RPM speed range
- Magtrol LabView based controller

Data Collection System

- National Instruments cDAQ chassis
- SMBus collection and sampling
- National Instruments LabView-based control
- Veri-volt voltage isolation
- Current shunt current sense

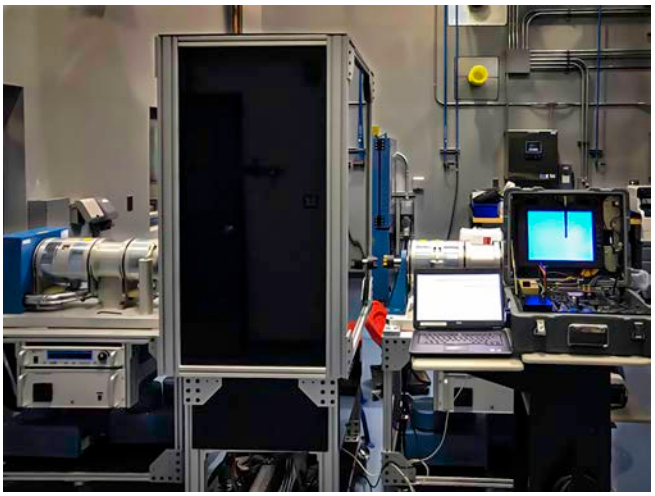
Environmental Control

- Temperature: -60 to 160°C
- External Russels Thermal Products system
- Multipoint thermocouple/RTD monitoring
- Humidity: up to 95% RH

General Information

- Thermal test chamber sized to MTRS Inc II and smaller robotic platforms
- Thermal test chamber and dynamometers are mobile
- CRS-I ready with minimal modification
- Remote Operation ready
- Large Robotic Assembly area

R-PEVEL - TALON (Cold Mobility Test)



R-PEVEL - Battery Performance Test

POC
Igor Baseski
igor.baseski.civ@army.mil

GROUND VEHICLE MATERIALS ENGINEERING (GVME)

Ground Vehicles Materials Engineering (GVME) provides technical expertise in materials engineering for the weapon system lifecycle from research to acquisition to sustainment. Technical competencies include lightweight materials maturation and integration; design optimization/weight reduction; materials selection, characterization, and failure analysis; joining technologies (welding, adhesives, mechanical fastening); additive manufacturing application; corrosion prevention and control; coatings (paint, surface finishing); and environmental and hazardous materials management. GVME operates the Material Characterization Lab (MCL) an ISO 17025 accredited lab that performs material characterization, failure analysis, research, and testing to provide innovative solutions and recommendations to customers.

GROUND VEHICLE MATERIALS ENGINEERING (GVME)

ADVANCED MATERIAL APPLICATIONS & MANUFACTURING

OVERVIEW

Ground vehicle system weights have risen in weight in response to new and increasing threats and increasing protection areas. The Application and Integration Team investigates and matures material technologies; provides weight reduction and design optimization engineering support for integration into DoD ground vehicle systems and support systems.

COMPETENCIES

MATERIAL MATURATION - Transitioning lightweight materials to ground vehicle systems

WEIGHT REDUCTION & DESIGN OPTIMIZATION

Design optimization for weight reduction using commercially-available design tools

LIGHTWEIGHT COMBAT VEHICLE S&T CAMPAIGN (LCVSTC)

GVSC investigated and identified a set of processes, tools, technologies and materials for vehicle light-weighting and developed a plan called the LCVSTC. The holistic light-weighting approach recommended is an integral part of future ground vehicle concepts and optimization studies, directs future force vehicle studies and concept vehicle iterations, and helps determine what variables will enable the Army to become more expeditionary.

CURRENT MAJOR PROJECTS

Loads Design Optimization

- Acquire design loads for ground combat vehicles
- Develop design guides and a generic vehicle design model for design optimization
- Lightweight/optimization of Army ground vehicle systems/components and parts
- Ability to effectively use virtual optimization tools
- Know and control design safety factors
- Acquire design loads for ground combat vehicles
- Develop design guides and a generic vehicle design model for design optimization
- Lightweight/optimization of Army ground vehicle systems/components and parts
- Ability to effectively use virtual optimization tools
- Know and control design safety factors

Advanced Lightweight Running Gear Design Optimization

- Cost-informed prototype lightweight road wheel/ suspension components for combat vehicles
- Prototypes developed will be tested to prove durability and develop component fatigue models and evaluated on a vehicle
- Final recommendations will be made for which cost effective lightweight approaches have the best potential for a successful transition to production in the future

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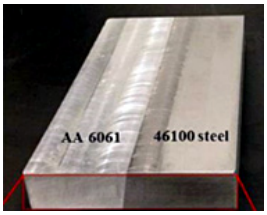
JOINING – WELDING/MECHANICAL FASTENERS/ADHESIVES

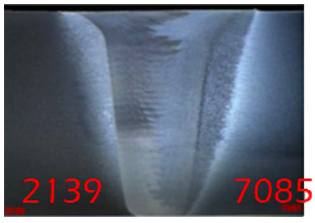
MISSION

To provide materials joining solutions through our technical expertise across the life cycle of military ground vehicles and support systems.

OVERVIEW

- Practically every segment of ground vehicle systems involves at least one aspect of joining.
- Welding is a complex engineering discipline that involves multiple characteristics from many competencies:
  - Materials Science
  - Metallurgy
  - Electrical Engineering
  - Mechanical Engineering
  - Design & Inspection
  - Automation
- Our team of engineers is specialized to use their advanced knowledge and skills to solve problems.
  - Provide solutions to problems involving fabrication of metallics, composites and dissimilar materials
  - Knowledge base of production specifications, properties and characteristics of materials, and engineering principles
  - We ensure that vehicle structures and components are safe and a benefit to the Army

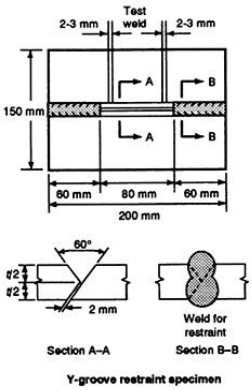


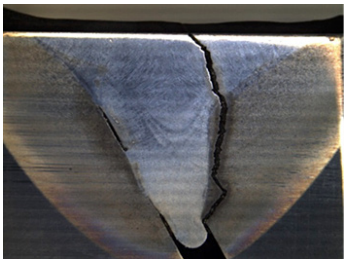


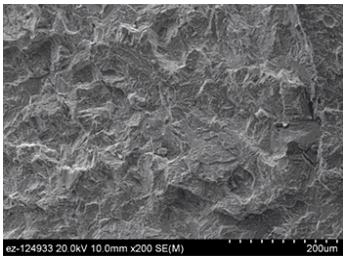
Dissimilar Material Joining Steel to Aluminum and Aluminum to aluminum (Different series)

RESEARCH AREAS

- Fusion based welding, i.e. Gas metal arc welding (GMAW), Gas tungsten arc welding (GTAW), Shielded metal arc welding (SMAW)
- Solid state welding, i.e. Friction stir welding (FSW)
- Dissimilar material joining (welding, adhesives and hybrid solutions)
- Hydrogen embrittlement and advanced characterization of welds and filler material
- Filler material development and weldability studies for new alloys and advanced materials
- Mechanical fastener evaluation and torque schedules and testing
- High strain rate adhesive evaluation and development
- Environmental exposure effects of joints







Hydrogen Embrittlement Testing on Welds

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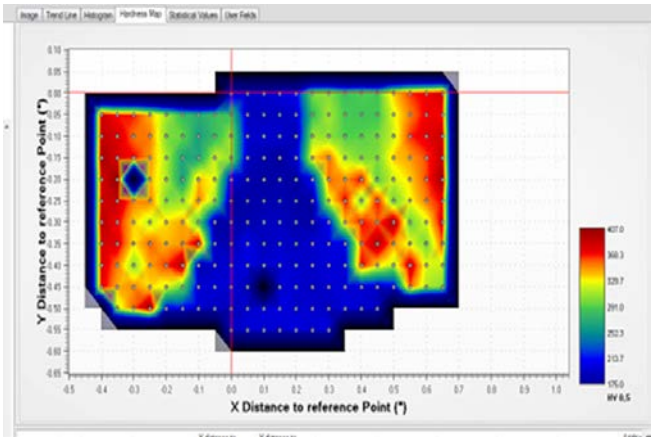
GROUND VEHICLE MATERIALS ENGINEERING (GVME)

COMPETENCIES

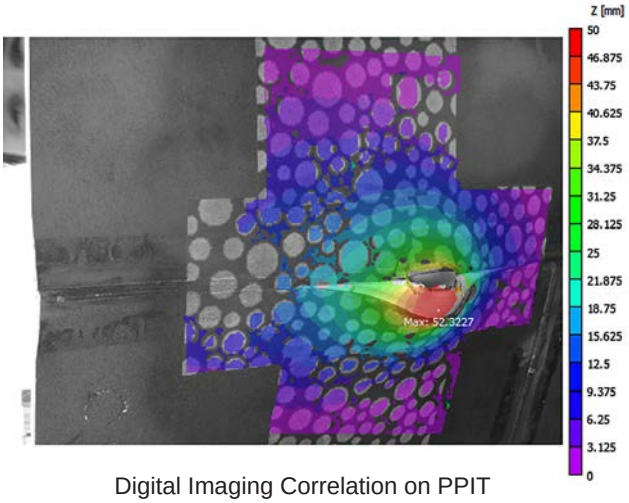
- Validation / verification of weld requirements
- Weld audits and quality inspections
- Non-destructive/destructive testing & evaluations
- Fastening & joining methods for novel materials
- Route cause analysis and mitigation strategies
- Contract language for weld requirements



Weld Hardness Mapping

CAPABILITIES

- Fusion welding (GMAW, GTAW, etc.)
- Friction stir welding & processing
- Ballistic weld certification and testing
- Joint characterization
- Digital Imaging Correlation (DIC)
- High strain rate evaluation
- Environmental exposure testing



Digital Imaging Correlation on PPIT

CUSTOMER SUPPORT

PROGRAM EXECUTIVE OFFICE COMBAT SUPPORT & COMBAT SERVICE SUPPORT
First to the Field... Last to Leave

PROGRAM EXECUTIVE OFFICE GROUND COMBAT SYSTEMS

Program Manager Light Armored Vehicles
Global Vision Global Mission

UNITED STATES SPECIAL OPERATIONS COMMAND

POC
Matt Rogers
matthew.j.rogers62.civ@army.mil

MATERIALS – ENVIRONMENTAL, COATINGS & CORROSION

ENVIRONMENTAL MISSION

The ECC Team provides environmental management support to ground vehicles and support systems from R&D through disposal.

OVERVIEW

Fully integrated Environmental Management program for weapon system programs to ensure environmental compliance and minimization of environmental hazards.

REGULATORY SUPPORT

DOD and Army Environmental Requirements

- Hazardous Materials Management & Reductions
- Environmental Risk Management - environmental hazard identification and tracking
- Programmatic Environment, Safety, and Health Evaluations (PESHE)

National Environmental Policy Act (NEPA) Compliance

- 32 CFR 651 Environmental Analysis of Army Actions
- Environmental Assessments
- Records of Environmental Consideration

General Environmental Regulatory Guidance

- EPA Regulations
- Engine Emissions Requirements
- National Security Exemptions

POLLUTION PREVENTION INITIATIVES

- Elimination/Minimization of hazardous materials used on weapon system programs
- Alternatives for Hazardous Materials - Identification and Test Support

CORE COMPETENCIES

Outdoor Exposure Testing of Cadmium-Free Electrical Connectors

Continued on next page...

GROUND VEHICLE MATERIALS ENGINEERING (GVME)

CORROSION & COATINGS MISSION

The ECC Team provides corrosion & coatings technical support to ground vehicles and support systems from R&D through disposal.

OVERVIEW

Complete corrosion and coatings technical support for weapon system acquisition programs to include paint, plating, and corrosion preventative compounds

R&D SUPPORT

- Proof-of-concept testing for novel corrosion preventative materials and methods
- Coatings evaluation and analysis
- Non-metallic corrosion inhibitors
- Corrosion requirements for GVSC prototype programs
- Alternative technologies and processes evaluation and adoption
- Corrosion Modeling and Simulation for vehicle systems

SUSTAINMENT SUPPORT

Field Corrosion Issues

- Vehicle assessments and data collection
- Application of coatings & inhibitors
- ECP reviews
- Cleaning procedures

Storage Solutions

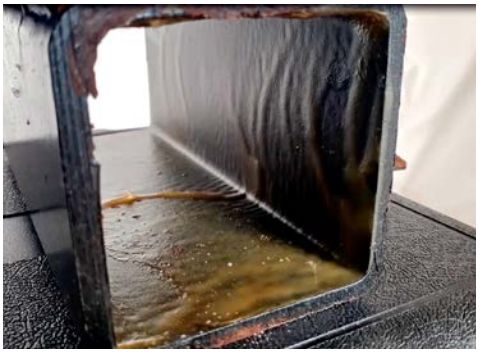
- Dehumidification
- Covers
- Rust preventative compounds

Secondary Item Procurements

- Coatings and corrosion technical guidance
- Identification of alternatives for obsolete specifications
- Mold/Mildew Issues – Mitigation Solutions

CORE COMPETENCIES

Frame member affected by severe in-service corrosion



Specimen protected by cavity wax during corrosion testing

MATERIAL TESTING LABORATORY (MTL)

OVERVIEW

The Material Testing Laboratory (MTL), under the Characterization & Failure Analysis (CFA) team, is an ISO 17025 accredited lab that performs material characterization, failure analysis, research, and testing to provide innovative solutions and recommendations to customers.

- Expertise in metals, adhesives, elastomers and plastics
- Project Examples:
  - Armor performance enhancements
  - Rubber track component life improvement
  - Transmission mount failure examination
  - Thermal performance of elastomers, adhesives, and composites
- The CFA team also serves TACOM program managers as subject matter experts through:
  - Quantitative testing to inform refinements to military standards
  - Testing techniques that satisfy unique DoD requirements
- Additionally:
  - Testing, analyzing, and validating parts made via additive manufacturing
  - Provide materials reverse-engineering support
  - Polymer-based composites testing and failure analysis

Powder X-ray Diffractometer

Optical Emission Spectrometer

Scanning Electron Microsope

Atomic Force Microscope

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MATERIAL TESTING LABORATORY (MTL)

Material characterization and testing are the focus of the labs, which facilitate material selection, design, verification, improvement and failure analysis. The two laboratories are versatile in their approaches to problem solving and will employ technical experience to engage in innovative solutions to customer requests

METALLURGY LABORATORY

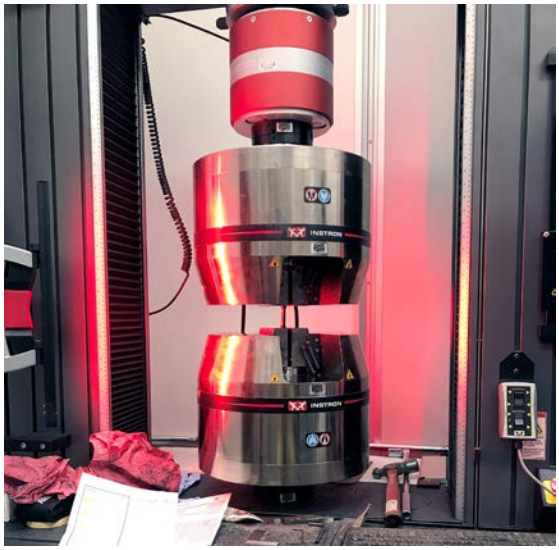
- Metallography
- X-Ray Powder Diffraction
- Surface Stress Analysis (X-Ray)
- Scanning Electron Microscopy (EDS, WDS, EBSD)
- Compositional Analysis - Optical Emission Spectroscopy (OES)
- Hardness Testing (Brinell and Rockwell Scales)
- Microhardness (Vickers and Knoop)
- Charpy Impact Testing
- Tensile Testing
- Fatigue Analysis
- Atomic Force Microscopy (AFM)
- High load tensile/compression testing

ELASTOMER LABORATORY

- Dynamic Mechanical Analysis (DMA)
- Heat Build-Up (HBU)
- Crack Fatigue Analysis (FCG)
- Glass Transition (DSC)
- Chemical Composition Analysis (FTIR)
- High Temperature Testing/Characterization
- Energy Management (Tension/Compression)
- Wear Resistance/Abrasion
- Compression Set
- Road Wheel Testing
- Bushing Testing
- Heat Aging
- R&D Compounding- Fibers/Nanoparticles

150kN Tensile Tester

Analytical Testing Room



600KNT Tensile Tester

RAPID PROTOTYPING LABORATORY

The Rapid Prototyping Lab (RPL) falls within the Ground Vehicle Materials Engineering (GVME) directorate and utilizes polymer 3D Printing/Additive Manufacturing to produce parts for various customers. The usage of these parts includes fit-check, temporary field repairs, and permanent vehicle use.

CAPABILITIES

The primary capabilities used within the RPL are polymer 3D printers. These machines range from small desktop machines (identical to fielded systems) to industrial machines capable of producing parts that can withstand a lifetime in the engine bay of a vehicle. The RPL also has a 3D scanner that is used to either generate geometry from existing parts or to validate as-printed geometry against existing CAD data.

EXAMPLES

- Low Velocity Air Drop (LVAD) Support block. Three design iterations tested over a two week period, final design prevented critical parts failing during LVAD testing
- Suspension Position Sensor Arm temporary replacement: Tested several machines/materials to validate this temporary repair piece for expeditionary manufacturing/use
- Manufactured forming tools that enabled our composites team to make custom geometries from carbon fiber sheets
- Designed and built electrical covers located in an engine bay to prevent water ingress, ultimately replaced the OEM design
- HMMWV Door Handle temporary replacement: Tested several machines/materials to validate this temporary repair piece for expeditionary manufacturing/use
- Ventilator replacement pieces: US Army Medical Command took old ventilators out of long-term storage and needed replacement chasses and panels as these external components could not be repaired
- Temporary Camera Cover: Designed and tested a temporary cover for two different weapon system cameras to prevent damage while the unit waited to receive OEM replacements. Covers were made from a rubber like material
- Travelled to a coastal Army facility with a scanning arm and worked with soldiers to scan large pump components on Army Watercraft Systems

LVAD Support Block

Suspension Position Arm

Engine Bay Electrical Cover

Temporary Camera Cover

Continued on next page...

GROUND VEHICLE MATERIALS ENGINEERING (GVME)

- Stratasys 450mc
  - Materials: ASA, PC, ULTEM, etc.
  - Build Area: 16 x 14 x 16 in
- HP4200
  - Materials: PA11 Nylon
  - Build Area: 15 x 11 x 15 in
- HP580
  - Materials: PA12 Nylon (Full Color)
  - Build Area: 13 x 10 x 7.5 in
- Formlabs 3L
  - Materials: Tough 200, Flexible 80A, etc.
  - Build Area: 13 x 8 x 12 in
- Markforged X7
  - Materials: Onyx, ESD Safe Onyx, FR Onyx + continuous reinforcement fibers
  - Build Area: 13 x 10.6 x 8 in
- Lulzbot Machines
  - Materials: PLA, ABS, Nylon (fielded materials)
  - Build Area: 11 x 11 x 10 in
- Makergear Ultra 1
  - Materials: PLA, ABS, Nylon (fielded materials)
  - Build Area: 16 x 14 x 13 in
- 3D Scanning Equipment
  - Hexagon RA8725 2.5m spherical measurement volume
  - Hexagon RA8740 4.0m spherical measurement volume
  - Contact Touch Probe - accuracy up to 6µm
  - 3D Laser (blue wavelength) Scanner - accuracy within 43µm
  - Area Scanner 3D white light scanning - accuracy within 43µm

Ventilator Housing

HMMWV Door Handle

Full Color Demonstration

POC
Matt Ludkey
matthew.p.ludkey.civ@army.mill

GROUND VEHICLE ROBOTICS (GVR)

Ground Vehicle Robotics' mission is to develop, experiment, demonstrate and transition autonomy enabled ground systems capabilities and technologies to meet and shape Army requirements. GVR wants to be the first choice of technology and engineering expertise for ground vehicle systems and support equipment - today and tomorrow.

CAPABILITIES

Detroit Arsenal offers four full high bays capable of housing full size tactical and combat systems so that integration work can be performed. Lab bench SIL's and HIL's allow synchronous work in vehicles while adjacent technology is proven on bench. On site there is an approximate 13 acre open area with grass, trees, and an asphalt loop allowing field testing of systems without requiring shipment to a full test range until they are mature enough.

Selfridge ANG Base offers two high bays, several SIL areas, a general work and maintenance building and a four acre test area consisting of an asphalt loop as well as off road area with stone, sand and turf surfaces.

- Performs electrical and mechanical hardware design, fabricates and integrates modifications to existing base platforms based on user requirements
- Modeling/simulation of vehicles large and small, this includes hardware-in-the-loop simulations and testing/development of systems and vehicles from 30-pound robots to Strykers
- Interoperability Profiles (IOP) and Conformance Verification Tools (CVT). CVT provides the capability to verify vendor conformance against government-defined IOP profiles
- Including a Warfighter Machine Interface (WMI) SIL where personnel can physically interact with upcoming operational control systems and configurations

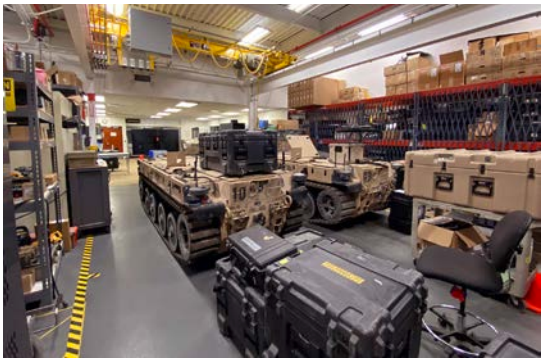
The facilities support customer efforts such as; Common Robotic System (Individual), Combat Vehicle Robotics (CoVeR), Autonomous Tactical Vehicle Systems (ATVS), Robotic Combat Vehicle (RCV) and small Dismounted Systems such as GVRBot, Project 10X, and SMET.

POC

Henry Andrusz
henry.j.Andrusz.civ@army.mil

BENEFITS

The benefits of small test areas adjacent to Bays and SIL's is the capability to do rapid prototype and revision then test prior to deploying for full scale testing at a range or base.



RCV-L Staged for Local Testing

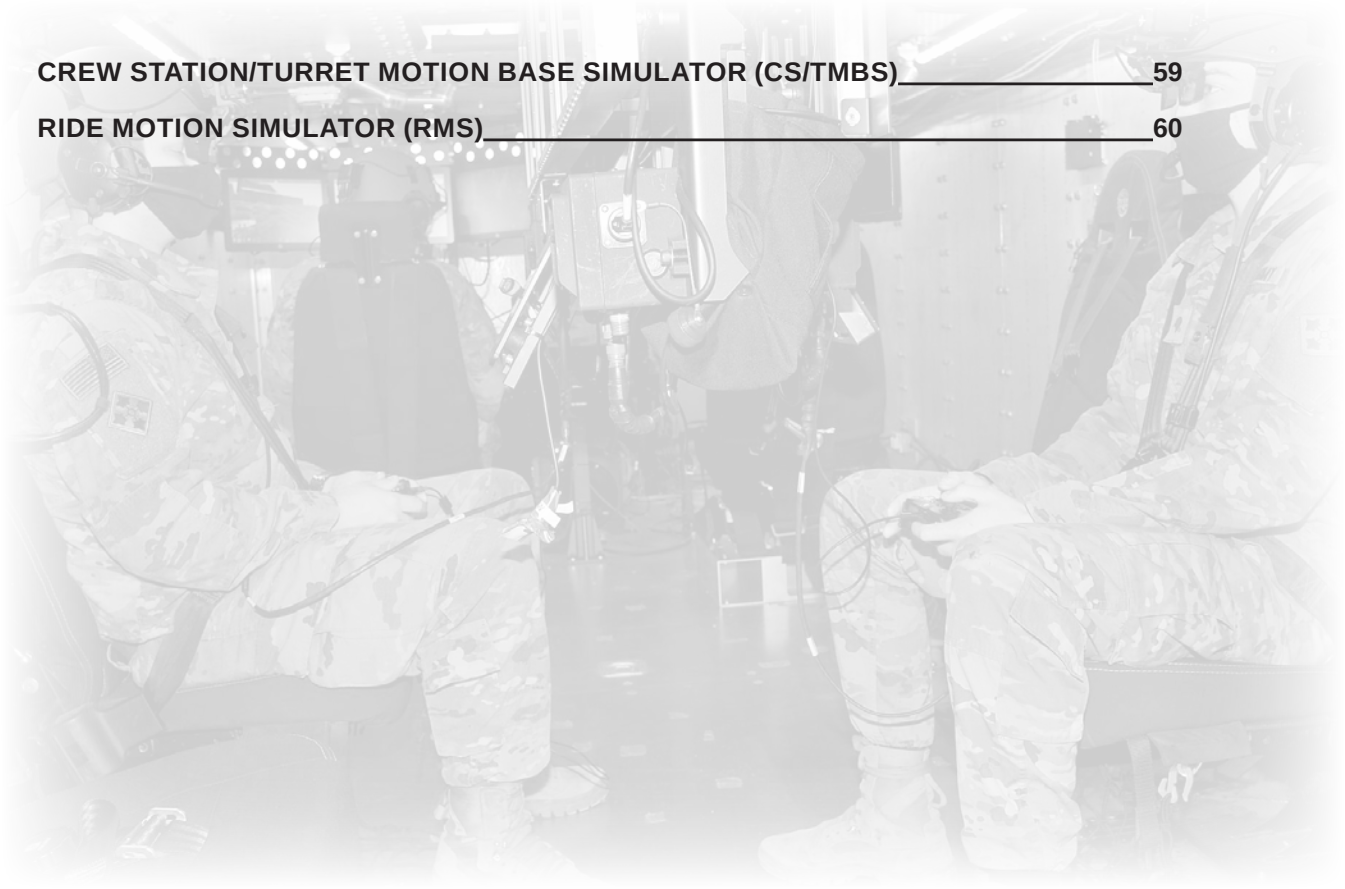
ATVS Simulator

Dismounted Systems Assembly and Troubleshooting SIL

Ground Vehicle Simulation Laboratory (GVSL)

GVSC's Immersive Simulation (IS) Directorate develops and executes state-of-the-art, Soldier-centric simulations in support of virtual experimentation, immersive visualization, and in-the-loop technology development. These immersive simulation capabilities provide stakeholders key data and information to develop early on system requirements/Tactics, Techniques, and Procedures (TTPs), explore novel crew station technologies, visualize/review ground vehicle system concepts, and more quickly/efficiently develop and test the latest Robotic/Autonomous System (RAS) solutions. The Ground Vehicle Simulation Laboratory (GVSL), within IS, boasts two unique motion-based simulator assets that provide both Soldier and system-in-the-loop simulation capabilities to look at a myriad of vehicle and vehicle crew station challenges.

POC: Victor Paul



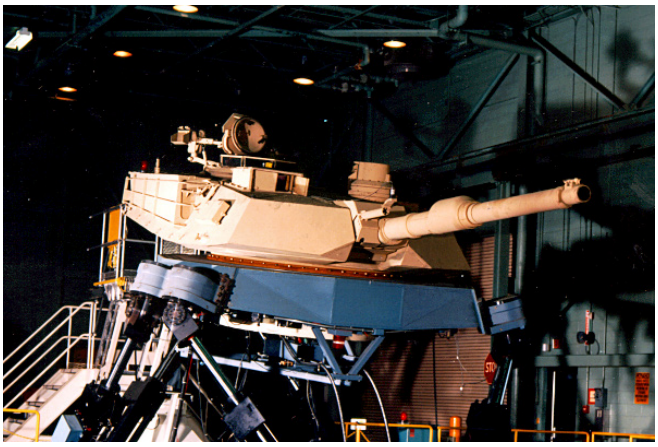
Ground Vehicle Simulation Laboratory (GVSL)

CREW STATION/TURRET MOTION BASE SIMULATOR (CS/TMBS)

OVERVIEW

- Reconfigurable cab can accommodate entire crew.
- Can replicate current vehicle layout or concept vehicle crew configuration.
- Accommodates “Active” Combat Vehicle Turret Systems to test gun/turret drive and weapon stabilization
- Hexapod configuration (Stewart Platform)
- 6 Degrees of Freedom (6-DOF: Lat, Long, Vertical
- (Heave), Roll, Pitch and Yaw)
- Hydraulically Actuated
- Replicates the “ride” of military ground systems over several terrain types, including field collected data or analytical models
- Human in the loop real-time vehicle dynamics
- Human Safety Rated, commissioned in 1989

CS/TMBS Performance Specs	
Maximum Payload	0-25 tons
Acceleration Bandwidth	10-20Hz
Axes Displacement	
• Linear (long, lat, vert)	±1m
• Angular	±20°
Max Accel w/ Max Payload	
• Linear	4g
• Angular	30 rad/sec^2
Accuracy	
• Linear	> 97%
• Angular	> 97%



M1A2 Turret on CS/TMBS

Reconfigurable Mission Module on CS/TMBS

Mission Module Interior

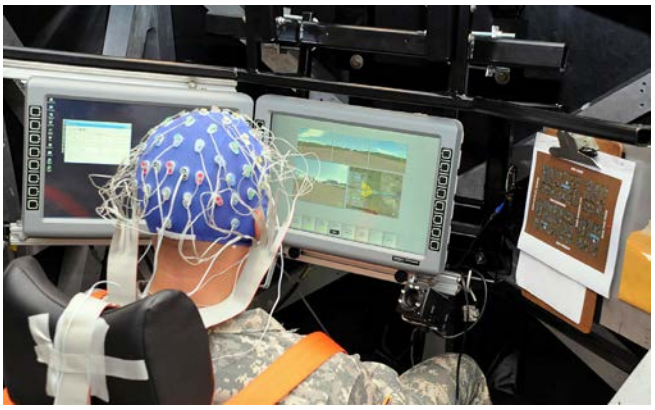
RIDE MOTION SIMULATOR (RMS)

OVERVIEW

- Single occupant reconfigurable cab
- Designed for crew station and soldier-in-the-loop virtual experimentation
- Capability to test new seating for current systems.
- Hexapod configuration (Stewart Platform)
- 6 Degrees of Freedom (6-DOF: Lat, Long, Vertical
- (Heave), Roll, Pitch and Yaw)
- Hydraulically Actuated
- Replicates the “ride” of military ground systems over several terrain types, including field collected data or analytical models
- Human in the loop real-time vehicle dynamics
- Human Safety Rated, commissioned in 1997

RMS Performance Specs	
Maximum Payload	1500lb
Acceleration Bandwidth	40 Hz
Axes Displacement	
• Linear (long, lat, vert)	±0.5m
• Angular	±20°
Max Accel w/ Max Payload	
• Linear	2g
• Angular	20 rad/sec^2
Accuracy	
• Linear	> 97%
• Angular	> 97%

Soldier Riding on RMS



Crew Station Mockup in RMS Cab

GROUND VEHICLE SURVIVABILITY & PROTECTION (GVSP)

Ground Vehicle Survivability & Protection (GVSP) is responsible for holistic ground vehicle layered survivability and protection to ensure Soldiers maintain an operational capability against a peer advisory within a contested battlespace. Primary competencies emphasize interoperability with Vehicle Protection System Vehicle Base Kit (VPS VBK) MAF compliance for a layered protection including obscuration, ballistic armor, blast mitigating technologies, plus soft/hard kill avoidance initiatives that include LASER and unmanned aerial system (UAS) mitigation for the Department of Defense ground vehicles including internal power, environmental controls and fire protection. Specialty areas cover the utilization of specialized test fixtures, test rigs, instrumentation systems (including Anthropomorphic Test Devices) and live-fire ranges for testing and evaluation of protection technologies for an overall integrated system designed to accommodate the Soldiers' operational environment within the platform and protect them from hazards encountered within combat and tactical wheeled vehicles. GVSP uses its unique in-house laboratories and off-site ranges for subject matter experts to reinforce its reputation as the Army's technical authority on survivability.

FIRE PROTECTION TECHNOLOGY INTEGRATION LABORATORY (FP TIL)

The Fire Protection Technology Integration Laboratory (FP TIL) provides resources that allow for faster and more thorough evaluation of emerging automatic fire extinguishing system (AFES) technologies and agents to support the Army's modernization plans for future and legacy vehicles. It also enables researchers to develop methods to evaluate new fire protection technologies for future applications.

This important lab providesDEVCOM Ground Vehicle Systems Center with integration and testing capabilities to evaluate the performance of existing and emerging extinguishing components and agents.

The lab features a ballistic fireball simulator, reconfigurable test enclosure, and an ability to perform high-speed agent concentration analysis.

This facility can support integration and engineering test and evaluation of AFES designed to protect watercraft, tactical and armored manned/unmanned ground vehicles including:

- Abrams
- MRAP
- BFV
- FAASV
- Stryker
- HEMTT
- M-ATV
- Other current and future military vehicles

FP TIL reconfigurable chamber, used for fire protection research and vehicle integration testing

FP TIL forced ventilation and filtration system

Continued on next page...

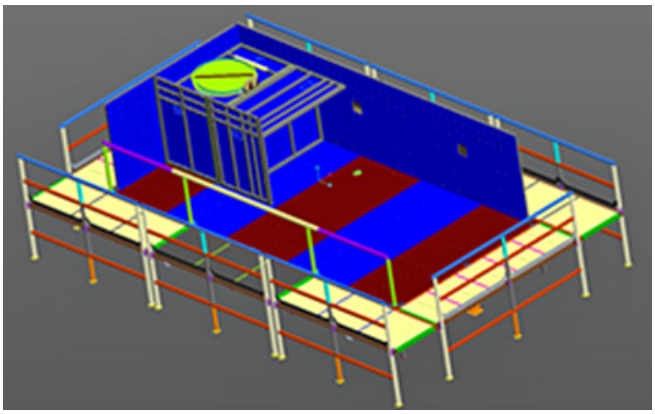
FIRE PROTECTION TECHNOLOGY INTEGRATION LABORATORY (FP TIL)

DEVCOM Ground Vehicle Systems Center is researching ways to improve fire resistance and increase vehicle protection by addressing fire vulnerabilities with current and emerging threats.

RESEARCH

- Environmentally friendly agents
- Integration and evaluation of vehicle/crew fire suppression systems
- Development of and conformance to material flammability, smoke and toxicity standards

Fireball Generator: The Fireball Generator creates and ignites a pressurized, heated fuel spray to simulate a ballistic event where a threat has penetrated a vehicle's fuel tank.

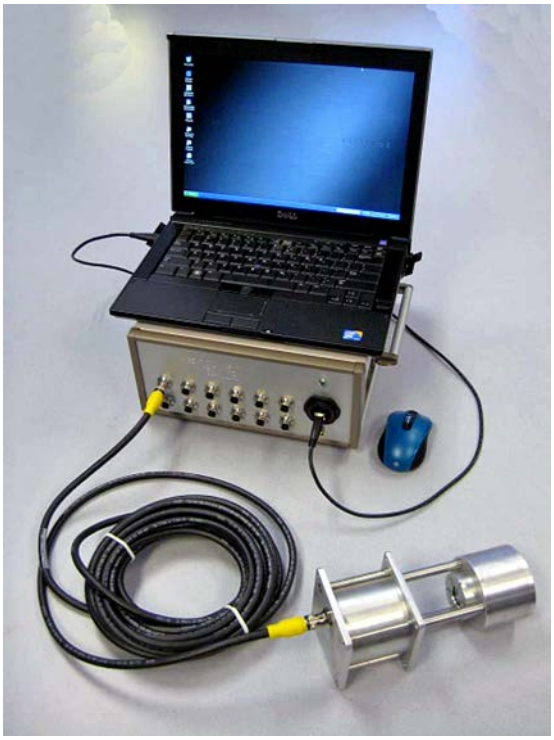


Reconfigurable Fire Box: The Reconfigurable Fire Box is able to replicate interior dimensions of all current and future tactical and combat vehicles.

POC
Jim Muldoon
james.p.muldoon3.civ@army.mil

OTHER AREAS OF INTEREST

- External fire protection systems
- Fuel tank vulnerability reduction
- Li-ion battery fire protection
- Electrical fire protection
- Ammunition fire protection



High Speed Agent Concentration Analyzer: DEVCOM Ground Vehicle Systems Center's unique capability to perform real-time, gaseous agent distribution measurements and assess AFES performance.

Agent Concentration Test: System installed in the Reconfigurable Fire Box. Sensors are mounted to monitor agent dispersion.

OCCUPANT PROTECTION LABORATORY OFF-SITE TESTING SUPPORT (OPL)

The Occupant Protection Laboratory (OPL) provides existing partnerships and experience to perform the testing with proven providers such as the Engineering Research and Development Center (ERDC), National Ground Intelligence Center (NGIC), and other contractor facilities.

The OPL can assist with the coordination and provide off-site test support for its customers with Data Acquisition Systems (DAS), ATDs, instrumentation, cameras, and test consulting.

CAPABILITIES

OPL Partners offer several scenarios to extend the subsystem performance and integration. OPL technicians instrument the test fixtures and subsystems to compare improvements against the baseline for:

- Dynamic rollover testing
- Generic hull underbody blast testing
- Vehicle born improvised explosive device (VBIED) blast testing

AVAILABLE INSTRUMENTATION

- 5th, 50th, and 95th Hybrid III ATD
- Accelerometers: 7264 style, 2K range or other upon request
- Load Cells: upon request
- High Speed Video: 5,000 fps

Generic Hull Live Fire Test

Generic Hull

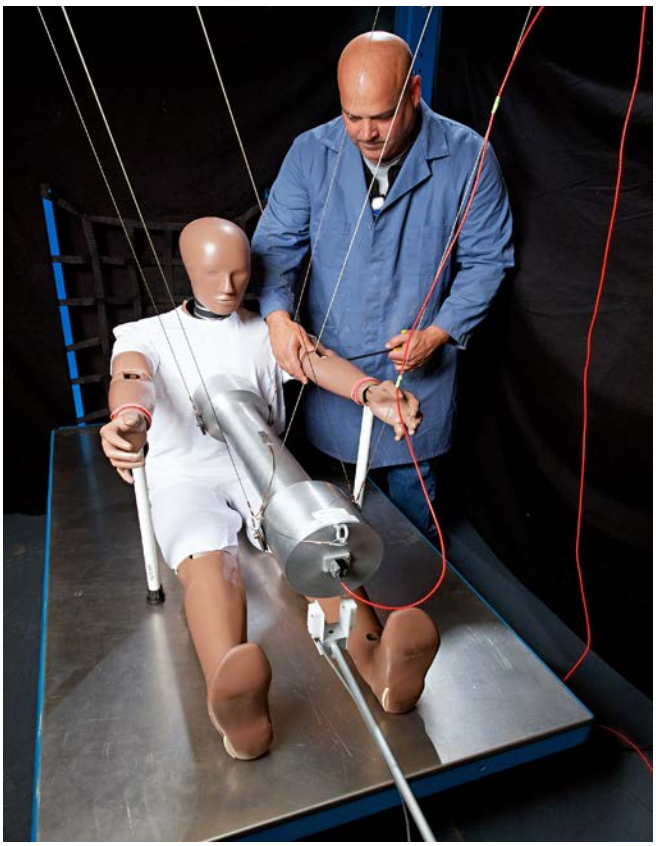
Vehicle Live Fire Test

ANTHROPOMORPHIC TEST DEVICE CERTIFICATION LABORATORY (ATD)

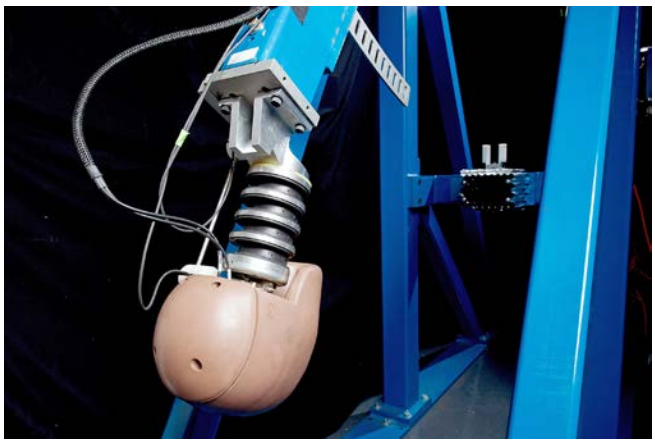
The Anthropomorphic Test Device (ATD) Certification Lab enables GVSC to certify ATDs and the Warrior Injury Assessment Manikin (WIAMan) in-house.

This lab has the experience to record data and test using ATDs and the WIAMan, thanks to subject matter experts who have been on the WIAMan development team from the very beginning. The ATD Lab owns 12 dummies, which they can certify, repair, and maintain after each test. This saves up to 6-8 weeks of time that would be required if they had to be sent out, reducing cost and downtime between testing events.

The ATD Lab is located within the Occupant Protection Laboratory (OPL), a full-service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems within six distinct testing capabilities. ATDs are utilized in multiple labs within the OPL, including the Crew Compartment Underbody Blast Simulator, Sub System Drop Tower, as well as in off-site live fire tests Distribution.



Thorax Impact Test Device



Neck Pendulum Test Device

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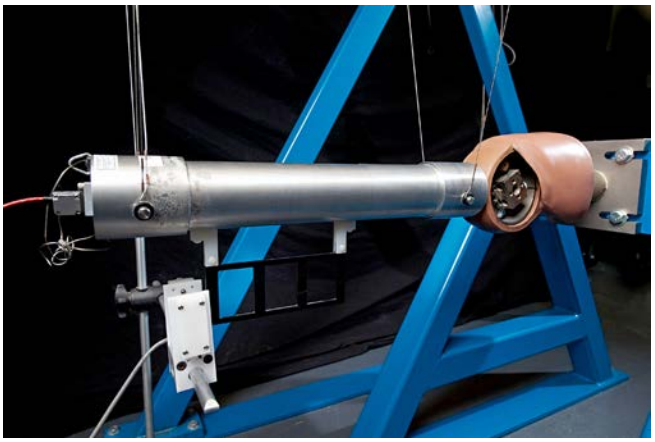
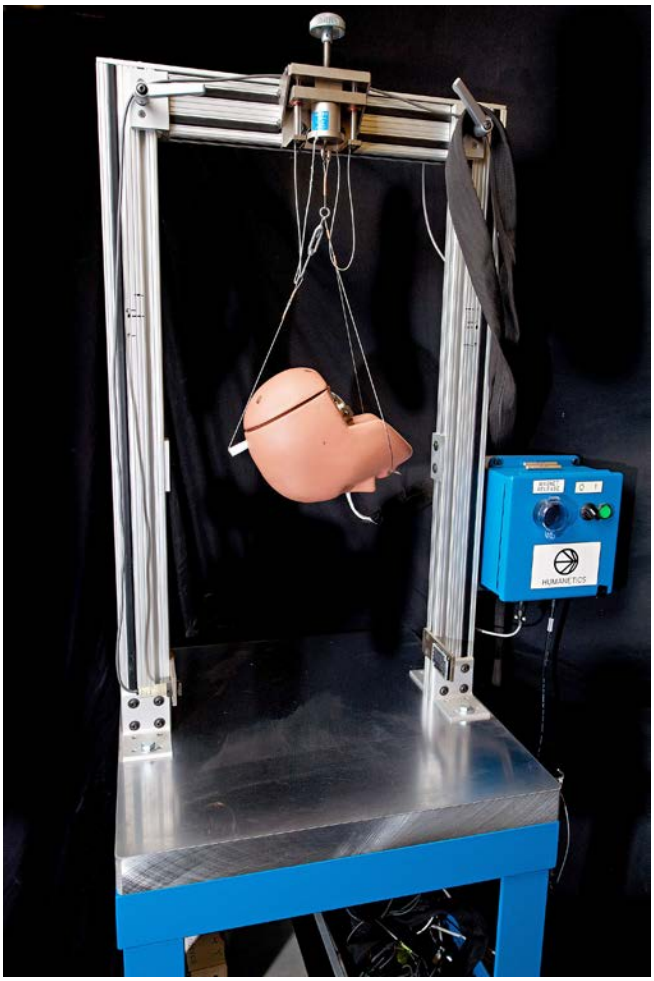
GROUND VEHICLE SURVIVABILITY & PROTECTION (GVSP)

KEY CAPABILITIES

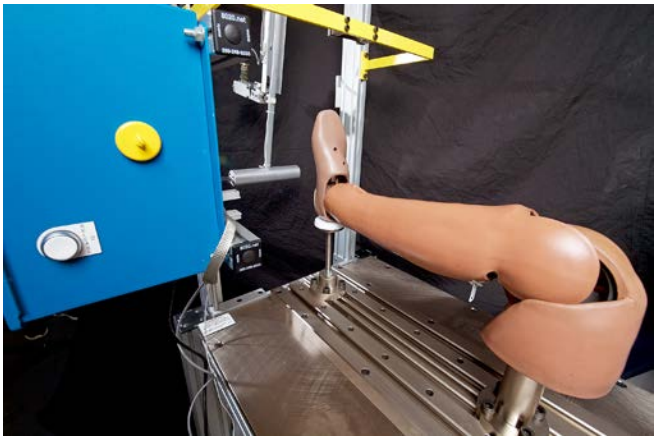
- Test fixtures to certify each body region of an ATD (head, neck, knee, thorax, foot)
- Compliant with CFR 49, Part 572 ATD
- Instrumentation conforms to SAE J211 standards
- 5th, 50th, 95th Hybrid III ATD and WIAMan (Warrior Injury Assessment Manikin)



Knee Impact Test Device



Head Drop Test Device

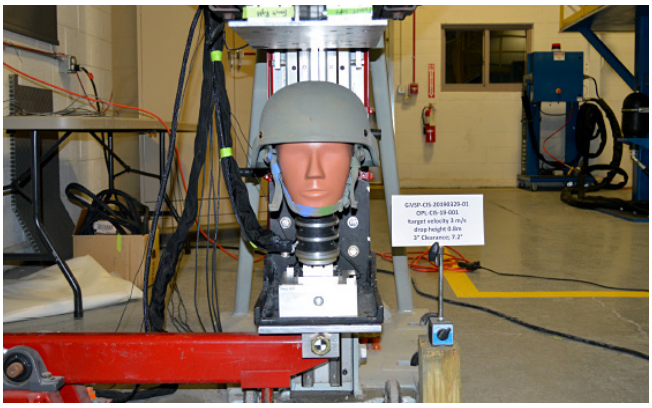


Foot Impact Test Device

COMPONENT IMPACT SIMULATOR (CIS)

The Component Impact Simulator (CIS) is a multipurpose test fixture used for component and subcomponent shock impulse testing. The test results are used to identify input parameters that are significant to component failure or occupant injury. The CIS provides the data required to generate algorithms that will predict the risk of failure or injury given the input parameters. This is a repeatable, non-destructive test methodology.

CIS is located within the Occupant Protection Laboratory (OPL), a full-service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems within six distinct testing capabilities.

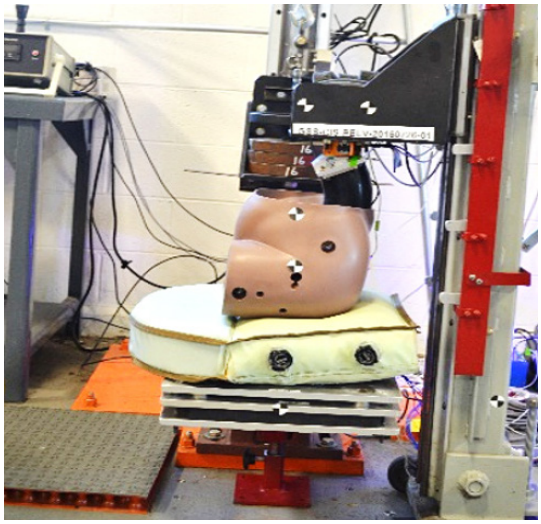


Head and Neck Testing

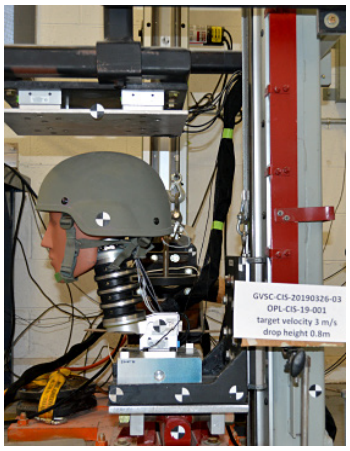
- Testing from 6 -10 m/s
- Head/Neck impact testing (with or without helmet)
- Lower-extremity testing (ATD leg from knee down)
- Pelvis impact testing (pelvis and lumbar)
- Evaluation of flooring, seat padding materials (foams, rubbers), vehicle trim, cargo retention, and electronics

AVAILABLE INSTRUMENTATION

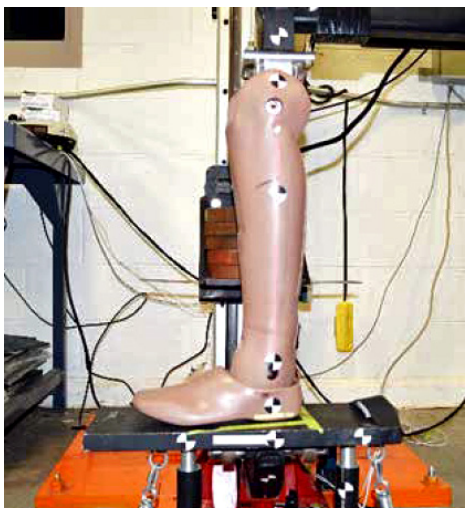
- 5th, 50th, 95th Hybrid III ATD and WIAMan (Warrior Injury Assessment Manikin)
- Accelerometers: 7264 style, 2K range or other upon request
- Load Cells: Compression load cells
- High Speed Video: 5,000 fps upon request
- Load Cells: upon request
- High Speed Video: 5,000 fps



Pelvic Impact Test



Head and Neck Assembly Test

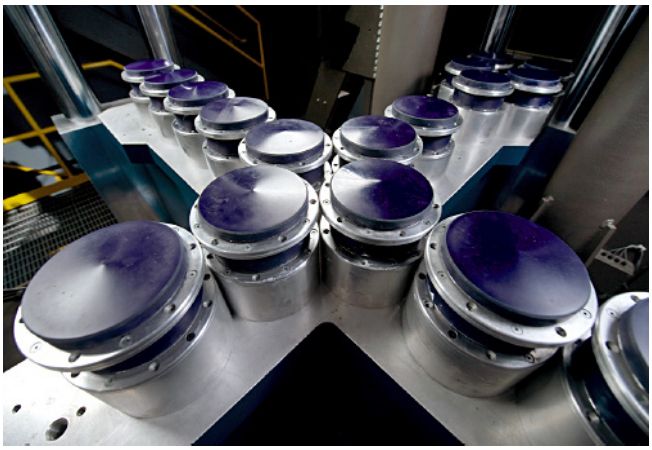


Lower Leg Testing

CREW COMPARTMENT UNDERBODY BLAST SIMULATOR (CCUBS)

The Crew Compartment Underbody Blast Simulator (CCUBS) is a pneumatically-actuated test device made up of a large platform capable of holding up to four seated occupants and used to evaluate vehicle crew compartments in simulated underbody blast events or material equipment drops. Testing is performed on system and subsystem items such as energy attenuating (EA) seats, bench seats, restraints, EA floors, floor mats, cargo retention devices, and any item that requires dynamic impact testing. CCUBS simulates the independent local and global forces that occur from an underbody explosive event (initial vertical and drop-down forces). This test device evaluates the occupants, occupant protection technologies, and components in a controlled, repeatable, and reproducible environment.

CCUBS is located within the Occupant Protection Laboratory (OPL), a full-service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems within six distinct testing capabilities. CCUBS can utilize Anthropomorphic Test Devices (ATDs), which are certified, repaired, and maintained within the OPL.



Programmers on Bullet Mass

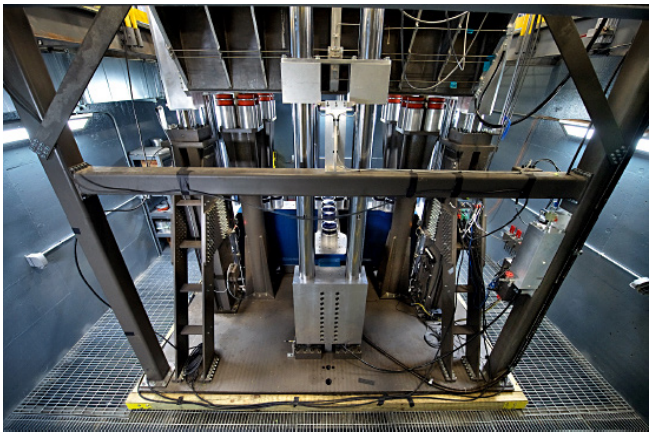
CAPABILITIES

- Testing impulses up to 350g - 5ms on a global level with slam down impulses up to 90g - 20ms
- Total payload is 2,200 lbs
- Platform size 8’ x 8’ (Warrior Injury Assessment Manikin)
- Accelerometers: 7264 style, 2K range or other upon request
- Load Cells: Compression load cells
- High Speed Video: 5,000 fps upon request

AVAILABLE INSTRUMENTATION

- 5th, 50th, 95th Hybrid III ATD
- Sample Rate: 10,000 - 20,000/sec
- Accelerometers: 7264 style, 2K range or other upon request
- Load Cells: lightweight seatbelt load cells
- High Speed Video: 5,000 fps

Readying ATDs on the CCUBS Platform in Preparation for a Test



Nitrogen-charged actuators accelerate the mass on the test fixture to induce the required impulse to simulate an IED

FLOOR INTERFACE TECHNOLOGY ACCELERATOR (FITA)

The Floor Interface Technology Accelerator (FITA) is a leg impact system used to evaluate the performance of energy absorbing floor materials, simulating an underbody blast. It could be adapted to test any component that requires being subjected to accelerative forces. The FITA consists of a rigidly mounted seat with a pneumatically-actuated piston that pushes against the foot of the occupant or resistive object. This test allows engineers to quickly evaluate the performance of the test item prior to more extensive testing on other Occupant Protection Laboratory (OPL) test fixtures or in live-fire events.

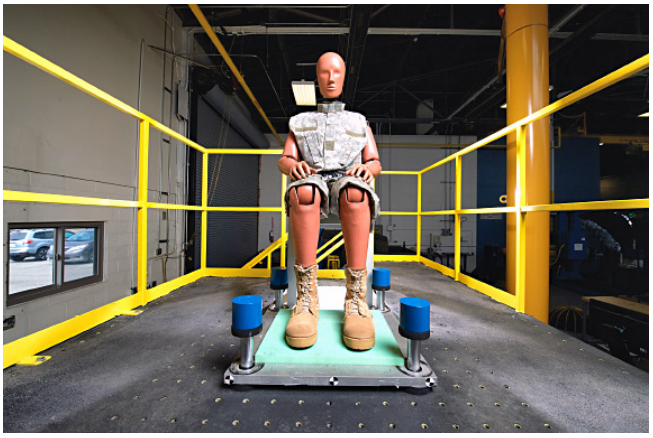
FITA is located within the (OPL), a full-service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems within six distinct testing capabilities. The OPL provides offsite testing support and coordination for a multitude of different types of survivability testing.

- Impactor velocity at 525 psi is approximately 14m/s
- Impactor velocity at 1,000 psi is approximately 18m/s
- Chair for dummy positioning
- Foot platform size: 2'x 2'

AVAILABLE INSTRUMENTATION

- 5th, 50th, and 95th Hybrid III ATD
- Accelerometers: 7264 style, 2K range or other upon request
- Load Cells: upon request
- High Speed Video: 5,000 fps

Floor Interface Technology Accelerator



ATD Seated In Position

HEAD IMPACT LABORATORY (HIL)

The Head Impact Lab (HIL) is an impact test machine used to test vehicle interior impact points that cause injuries to the head and extremities. The data provides information required to develop interior padding solutions that will reduce injuries to the head and extremities of occupants involved in a blast, crash, and rollover event in ground vehicles. The HIL fills a capability gap between component level testing, and system/vehicle level evaluation of occupant protection technologies.

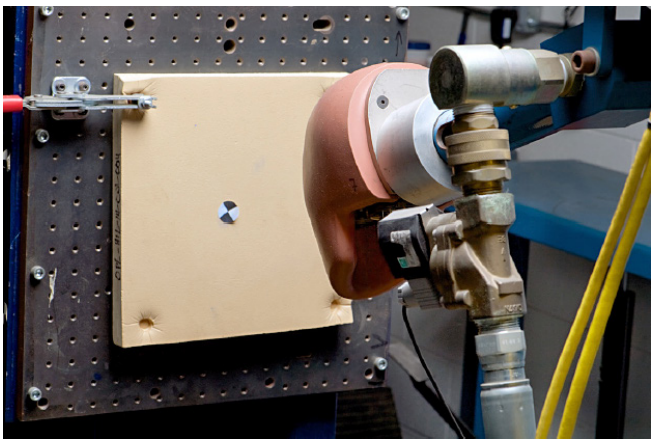
The HIL is located in the Occupant Protection Laboratory (OPL) a full-service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems within six distinct test capabilities. Researchers use the OPL to perform unique "out of the box" impact testing, as well as standardized testing on occupant protection and energy mitigation technologies.

CAPABILITIES

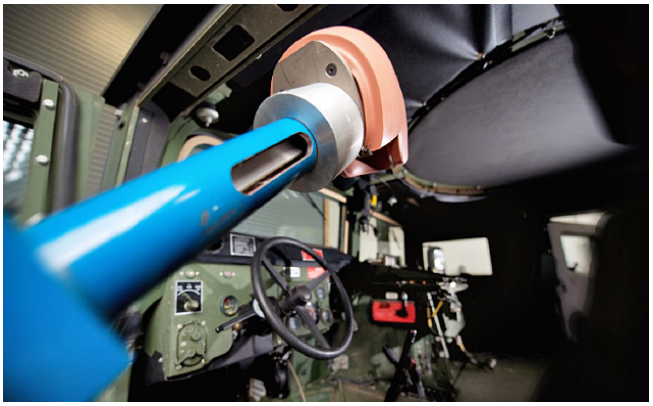
- The HIL is capable of testing speeds up to 24 kp/h (15 mph) using Federal Motor Vehicles Safety Standards 201u head form or with the European/ pedestrian head form with a mounted Advanced Combat Helmet
- Dynamic impact testing of energy mitigating materials
- The HIL is ISO/IEC 17025 accredited

AVAILABLE INSTRUMENTATION

- Accelerometers
- Load Cells
- High Speed Video



Close-up of head to hit EA material



Close-up of head to hit inside HMMWV

HIL with use of a HMMWV

SUB-SYSTEM DROP TOWER (SSDT)

The Sub-System Drop Tower (SSDT) is a device used to evaluate technologies that must endure dynamic impact testing. The drop tower consists of a 48” x 48” platform that has the capability to test a variety of system configurations such as floor, wall, or ceiling mounted energy absorbing (EA) seats, floor mat materials, EA floors, cargo retention devices, and data acquisition black boxes. The SSDT is capable of simulating a wide range of impulses and measuring the effects on the technology and/or occupant.

SSDT is located within the Occupant Protection Laboratory (OPL), a full service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems within six distinct testing

CAPABILITIES

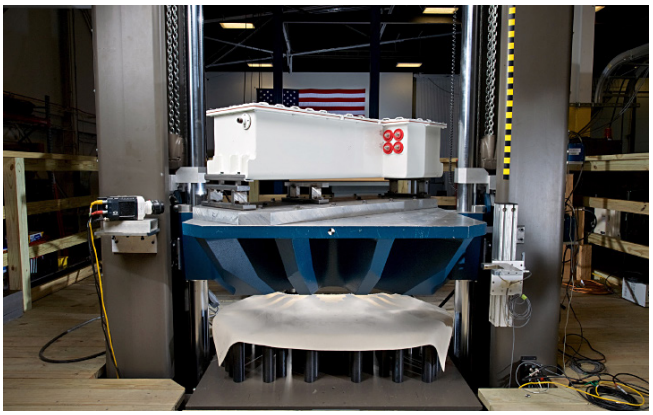
Impulses up to 1,000g durations from 2-10 msec

- Platform size 48”x48”
- Payloads depending on test configurations
- 1,100 lbs to 7,400 lbs

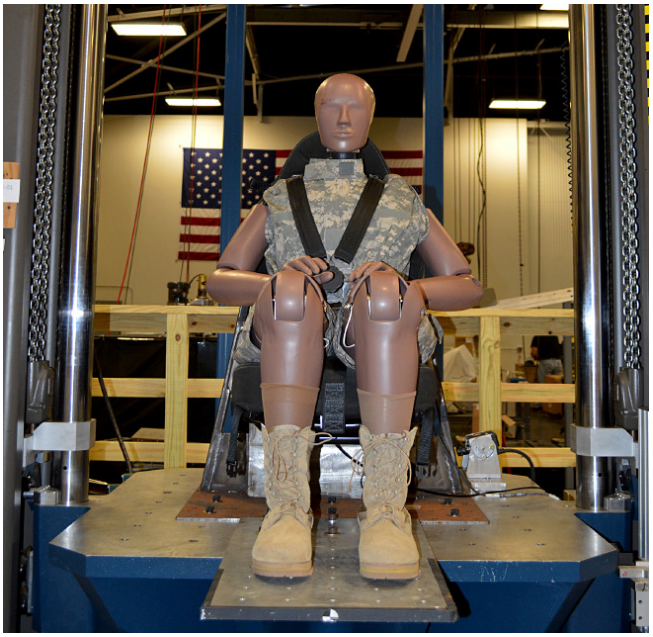
AVAILABLE INSTRUMENTATION

- 5th, 50th, 95th Hybrid III ATD
- Accelerometers: 7264 style, 2K range or other upon request
- Load Cells: upon request
- High Speed Video: 5,000 fps

Ammo Rack Retention Test



SSDT with Stryker Battery Box



Seat with Hybrid II Anthropomorphic Test Device (ATD) test

RAPID EVALUATION CAPABILITY (REC)

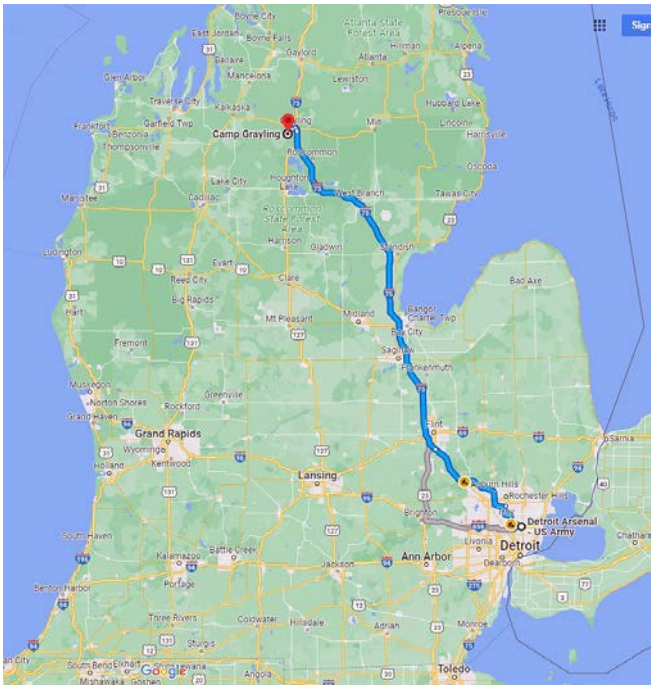
The Rapid Evaluation Capability (REC), uses a Mobile Experiment Lab to efficiently extend the REC's capabilities to remote reconfigurable locations such as Camp Grayling, MI. The REC can monitor and instrument an open range to use high value sites such as Camp Grayling's only high-explosive impact area in the state of Michigan to conduct year-round experiments and evaluations.

In coordination with the Michigan National Guard, REC can utilize more than 147,000 acres to develop and assess technologies and system integrations on platforms before they undergo validation tests.

BENEFITS

- Preliminary feasibility assessments are more cost effective than conducting actual tests
- Remote/Isolated location provides for discreet evaluation of technology readiness
- Controlled experiment/evaluation setting allows for repeatable yet rapid reconfiguration as necessary
- Mobile experiment laboratories facilitate immediate data capture, analysis and collaboration --anywhere/anytime

REC range configurations



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GROUND VEHICLE SURVIVABILITY & PROTECTION (GVSP)

CAPABILITIES

- Mobile Experiment Lab efficiently extends the REC's capabilities to remote reconfigurable locations
- Real-time experiments and evaluations of emerging technologies against high-explosive threats:
  - Explosively Formed Penetrators (EFPs)
  - Rocket Propelled Grenades (RPGs)
  - Anti-Tank Guided Missiles (ATGMs)
  - Recoilless Rifles
  - Mines
  - Direct-Fire Suppression
- Verifies medium-caliber armor manufacturing processes (i.e. welds) to quickly determine technology maturity
- Utilizes remote firing controls, multiple high-speed video camera angles and mobile experiment labs for real-time data/video capture and analysis
- Large workspaces and collaboration areas to host onsite After Action Reviews/discussions immediately following experiments

GVSP Test Trailer expands on both sides providing a large work area. Additional secure room in the goose-neck for sensitive material.

GVSP Expandable Test Trailer deploys to remote Test Range

Large work area inside the GVSP Test Trailer for briefings, meetings and running test operations

POC
Terry Hoist

SPECIAL SYSTEMS AND COMPONENT ENGINEERING LABORATORY

TESTS

- HVAC system testing
  - Real-time analysis of system conditions
  - Oil circulation tests
  - Airflow on vehicle
- Vehicle system power testing:
- Alternator bench to vehicle testing
- Environmental alternator bench testing

CAPABILITIES

- Environmental chambers
  - Sizes from 4'x4'x4' to 12'x15'x10'
  - -90 Deg F to 1000+ Deg F
  - Humidity
  - Solar load
  - Thermal shock up to pallet sized items
- Alternator testing
  - Up to ~1500 amps @ 28V
  - -80 Deg F to 225 Deg F
- Airflow5000
  - 20 CFM to CFM

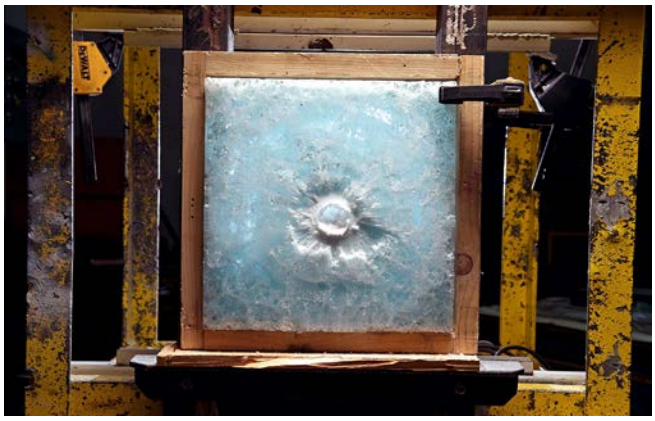
Alternator Test Inside Environmental Chamber

5000 CFM Airflow Bench

Large Environmental Chamber

Airflow on Vehicle

SURVIVABILITY ARMOR BALLISTICS LABORATORY (SABL)



OVERVIEW

The Survivability Armor Ballistics Lab (SABL) provides independent ballistic testing, data collection, data reduction, analysis, and qualification of armors. The lab conducts Automotive Tank Purchase Description (ATPD) 2352 and MIL- STD-3040 and 3057 qualification testing and supports customer-directed armor research and development.

BALLISTIC TESTING OF TRANSPARENT AND OPAQUE ARMOR SOLUTIONS

The SABL performs ballistic tests to multiple specifications including:

- ATPD 2352
- MIL-STD-662F
- STANAG 4569
- MIL-STD-3040
- MIL-STD-3057
- Customer directed test plans

Transparent, metallic, and composite armor coupons as well as vehicle armor components are tested in the SABL for research, first article, and product control purposes.

SABL INVENTORY

The SABL inventory contains more than 30 different projectiles which range
in size from 5.56mm to 105mm and include a variety of ammunition types:

- Ball
- Armor Piercing
- Plate-proofing Projectiles
- Fragment Simulating Projectiles

IMPACT CHAMBER

SABL's 1,440ft3 impact chamber is designed to accommodate large targets and/or system components. The lab has the capability to manufacture and assemble custom fixtures for complex targets as required. The SABL offers a walk-in environmental chamber to allow thermal cycling and testing of targets at hot or cold temperatures.

FIELD TESTING AT CAMP GRAYLING

SABL conducts large caliber ballistic shock evaluations at Camp Grayling's Multipurpose Range Complex

Capabilities include:

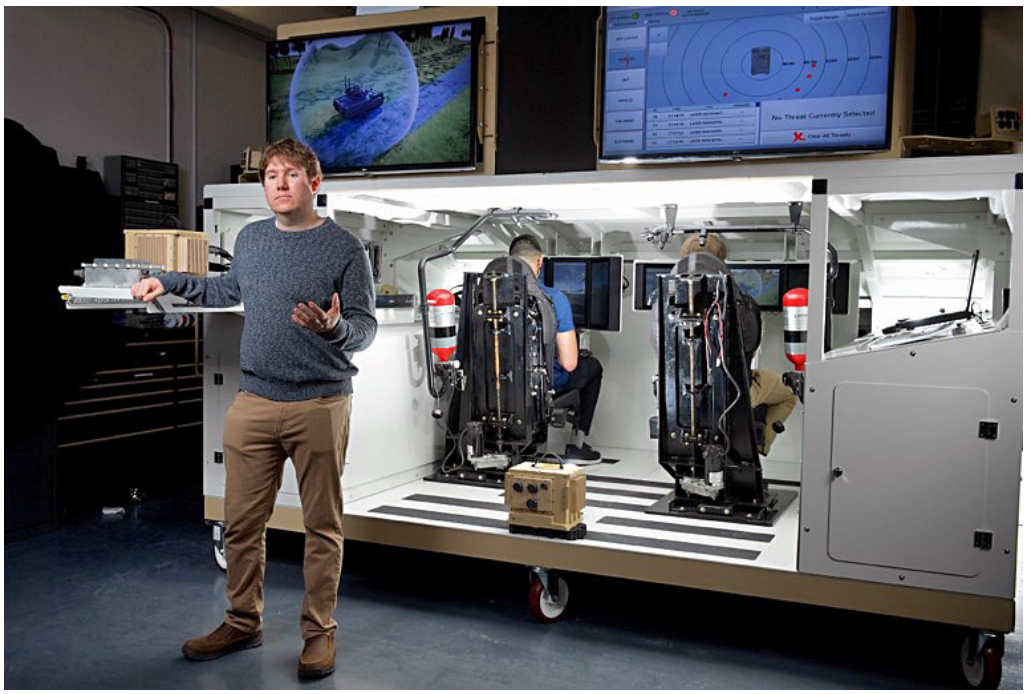
- 37mm, 57mm, and 75mm steel projectiles
- 37mm, 57mm, 75mm, and 105mm aluminum projectiles

Samples of various projectiles available for testing

High speed cameras are used to capture frame-by-frame ballistic impact data on targets

Impact Chamber

Target Setup for Weld Evaluation Testing



The Capability Assessment Buck (CAB) provides a representative ground platform crew compartment and allows Soldiers to operate the vehicle in the lab's Virtual Battlespace Environment (VBE) and train in the use of various vehicle protection systems.

VEHICLE PROTECTION INTEGRATION LABORATORY (VPIL)

OVERVIEW

The Vehicle Protection Integration Lab (VPIL) is an enduring capability within DEVCOM GVSC that provides the Army with an agile virtual prototyping environment and robust digital engineering services required for PdM Vehicle Protection Suites (VPS) to support technological requirements for both legacy and PM Maneuver Combat Systems (MCS). GVSC has made continuous investments in the VPIL to ensure state-of-the-art capabilities are provided to DEVCOM, DoD, and close allies, offering the best possible services to our Warfighters.

The VPIL is responsible for certifying system compliance to the Modular APS (MAPS) Framework (MAF), modeling platform configurations for optimization, CONOP / TTP development, and for providing advisory services to evaluate system effectiveness within specific geographic locations of interest. This work is accomplished through the use of multiple capabilities and tool suites, including our hardware-in-the-loop (HWIL) environment and modeling & simulation environment (Virtual Battlespace Environment, or VBE).

HARDWARE-IN-THE-LOOP (HWIL) ENVIRONMENT

- Enables connection of the MAPS Base Kit to APS hardware and software components to evaluate the performance of all devices
- Subsystems stimulated using representative threat data from the VBE or unique hardware stimulation mechanisms
- Analysis tools capture HWIL data exchanges, determine if subsystems are MAF-compliant, and feed data to endgame tools for further performance analysis (e.g. residual armor penetration and collateral hazard characterization)

VIRTUAL BATTLESPACE ENVIRONMENT (VBE)

- Direct stimulation of HWIL subsystems and endgame models with real-time data generated

Continued on next page...

by VBE, as well as visualization of resultant HWIL and endgame outputs
- Utilization of threat models generated by various DoD agencies to generate digital threat information for subsystems
- Modeling of theaters or ranges of interest utilizing geo-spatial data from both DoD agencies and open source communities
- Simulation fidelity is expected to grow as a function of time through use of additional physics-based models as well as the preprocessed results of high-fidelity physics-based tools

RECONFIGURABLE VEHICLE CAB

- Provides representative vehicle frame for performing subsystem integrations and demonstrations, integrated w/ VBE and HWIL
- Opportunity for man-in-the-loop experiments with Soldiers, offering candid feedback on APS configuration and MAPS Base Kit usability

BOTTOM LINE

The Vehicle Protection Integration Lab (VPIL) is an enduring capability within GVSC that directly supports PdM VPS' mission and vision. The mission of the VPIL is to enable the assessment, configuration, and optimization of AP subsystems, as well as compliance verification and validation of future AP subsystems to the MAF.

GVSC's expertise combined with the VPIL's hardware and software tool suites directly supports PdM VPS' mission to advance and rapidly deploy vehicle force protection technologies for legacy and PM Maneuver Combat Systems (MCS).

The VPIL continually evolves to interface with state-of-the-art capabilities in the APS M&S spectrum and links technology assessments with current capabilities. Capabilities with additional space for growth include: residual fragmentation modeling, probability of defeat estimates, terrain model generation, associated infrared, and radio frequency material modeling, and development of additional physics-based threat models.

GVSC is open to all sources of data and collaborations as required to advance the APS M&S capabilities for the US Army. This includes partnerships with DoD organizations, industry, bilateral engagements with foreign partners, and live-fire test results/data that can be integrated into the VPIL.

GVSC integrates all technologies and capabilities onto the fleet of ground combat platforms. With the support of the VPIL, GVSC acts as an honest broker for the US Army and other DoD allies in validating the performance of MAF-compliant AP subsystems and system configurations.

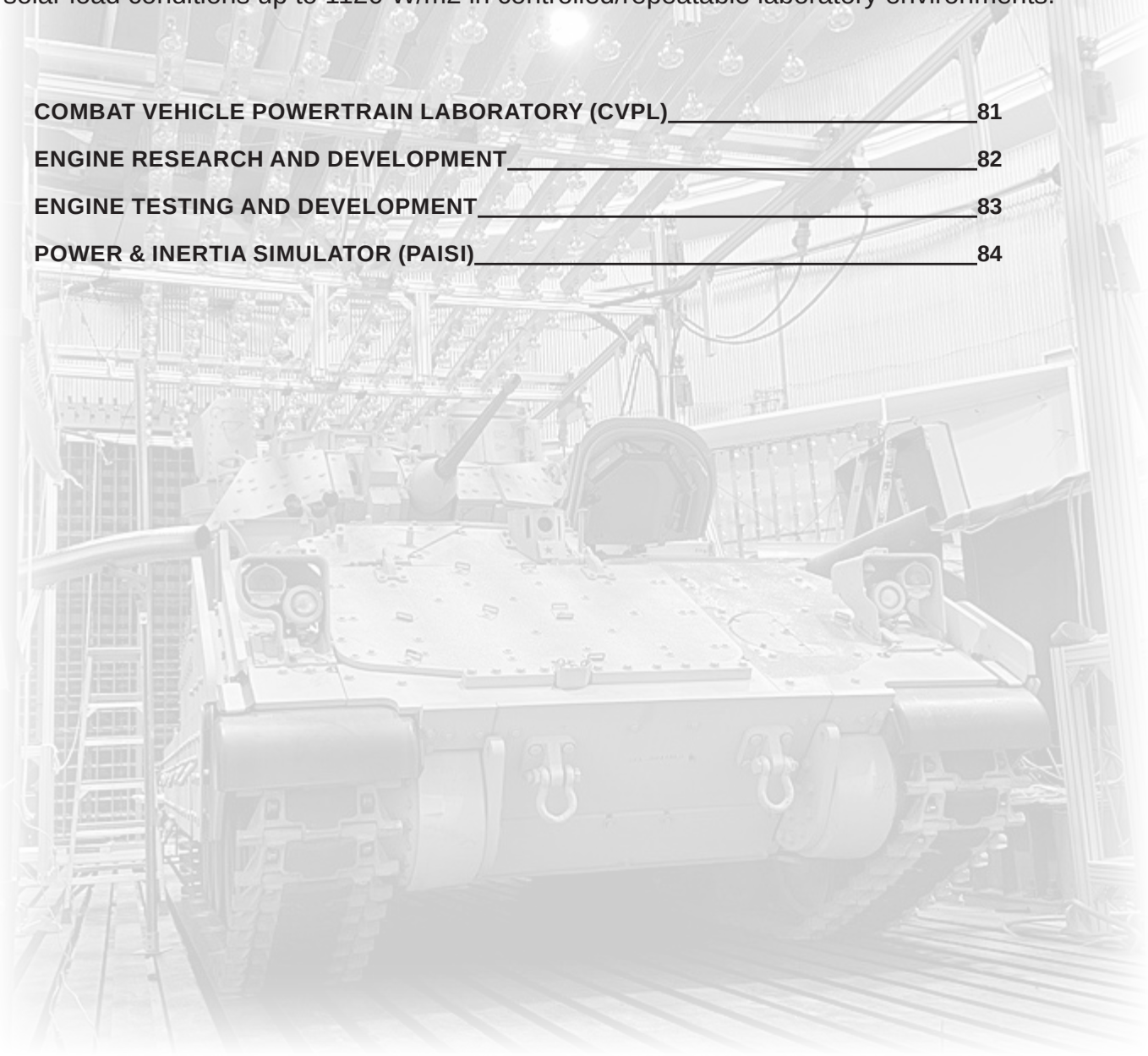
Displays inside the CAB replicate those used on various ground vehicle platforms.

Secure container enables classified vehicle protection integration efforts in the lab where domestic and foreign military contractor equipment can be utilized.

POC
James P. Muldoon
james.p.muldoon3.civ@army.mil

PROPULSION SYSTEMS LABORATORY (PSL)

GVSC's Propulsion Systems Laboratory (PSL) hosts nine dynamometer test cells which are all ISO 17025 accredited. The lab can perform multiple tests that cover engine, transmission, powertrain component, full powertrains, and vehicle-level testing. Eddy current, water brake, and AC dynamometers are used to test engines/transmissions/power packs to full vehicles ranging from 50 HP up to 3000 HP. All nine test cells offer various simulated field test conditions heat (from ambient temperature up to 160 °F), wind (speeds up to 20 mph,) and solar load conditions up to 1120 W/m2 in controlled/repeatable laboratory environments.



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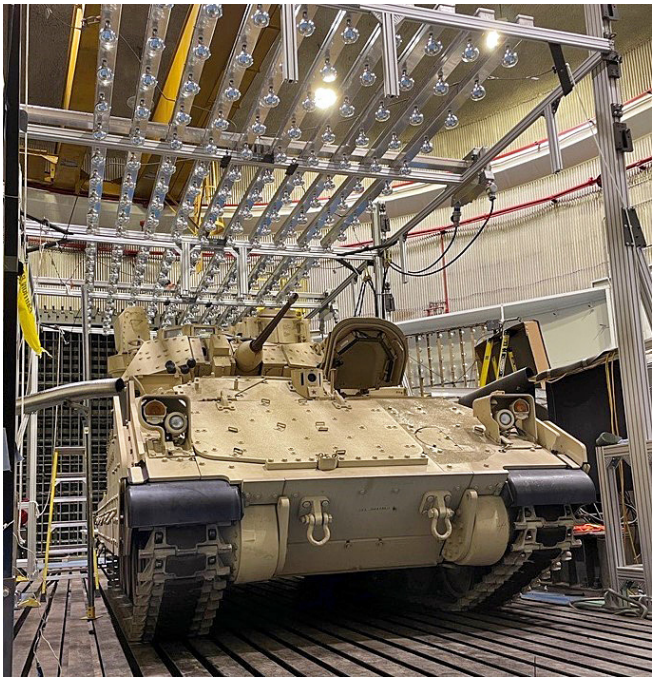
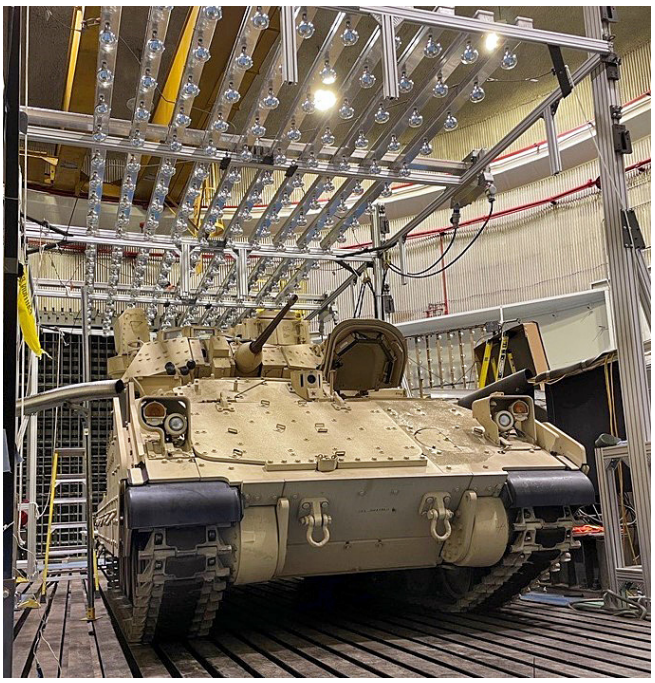
PROPULSION SYSTEMS LABORATORY (PSL)

PSL TESTING CAPABILITIES

- 9 Cells
- Controlled Environmental Temperatures
- NATO 400hr Testing
- Full-Load Cooling Testing
- Road Load Simulation
- HVAC Validation
- Electrical Powertrain Testing
- Powertrain Testing
- Project Research Development



Vehicle Testing



Engine Development

Engine Research Testing

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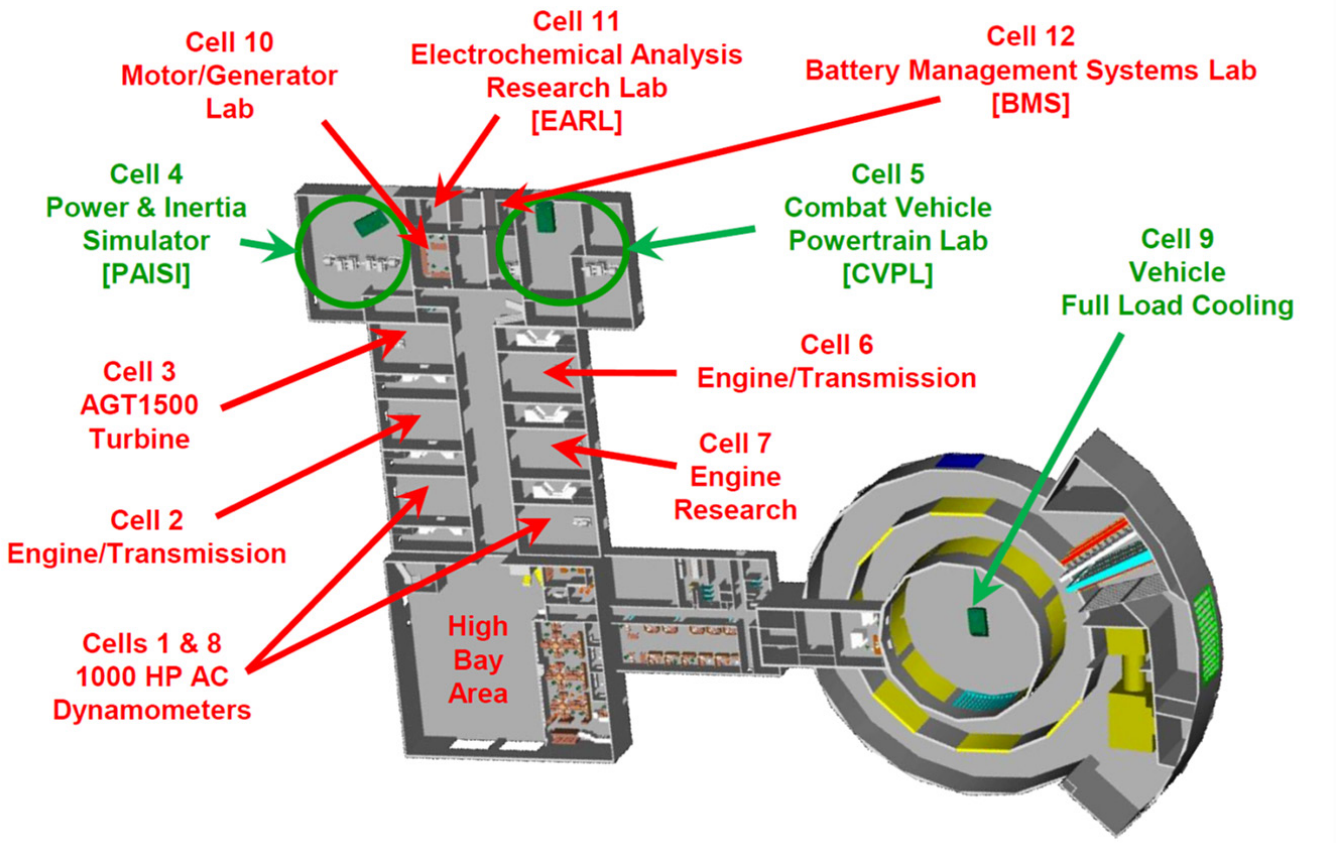
PROPULSION SYSTEMS LABORATORY (PSL)

PSL OVERVIEW



POC
John Hubble
john.e.hubble.civ@army.mil

PROPULSION SYSTEMS LABORATORY (PSL)

COMBAT VEHICLE POWERTRAIN LABORATORY (CVPL)

Test Cell 5 has regenerative AC dynamometers, control and test data acquisition systems, for up to 80 ton and 2000 HP tracked vehicles/powertrains. The test cell is supporting the Army's combat vehicle fleet modernization initiatives, future combat vehicle powertrains and customer requests for the evaluation of legacy engines, transmissions and vehicle systems under simulated road loading and transient operating conditions.

CAPABILITIES

- Replicates tracked vehicle loading up to 140,000 ft-lb per side
- Controlled temperature from ambient up to 1600F
- Air velocity control from 5 to 20 mph
- Solar loading up to 1120 W/m2
- More than 300 data channels available for monitoring and logging data
- Exhaust capacity commensurate with gas turbine air flow performance requirements

BENEFITS

- Unique facility for testing of fielded and developmental integrated heavy combat vehicle propulsion system performance and durability
- Provides transient testing, regenerative steer testing, road load simulation, hydrostatic steer unit testing, and transmission auxiliary load testing capabilities
- Laboratory controls multiple aspects of environmental conditions to enable reliable and repeatable testing for performance characterization, accelerated life testing and field failure replication/diagnostics

Combat Vehicle Powertrain Laboratory (CVPL)

Combat Vehicle Powertrain Laboratory (CVPL)

POC
John Hubble
john.e.hubble.civ@army.mil

PROPULSION SYSTEMS LABORATORY (PSL)

ENGINE RESEARCH AND DEVELOPMENT

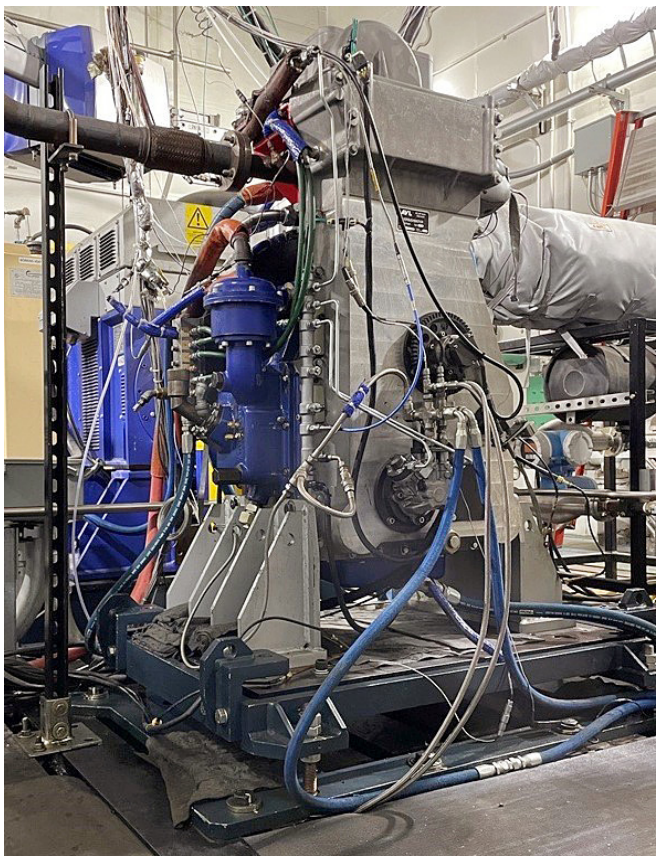
Test Cell 7 is a single cylinder diesel engine research facility resource dedicated to fundamental diesel engine combustion research using a precisely controlled engine system and environmental operating conditions.

CAPABILITIES

- Single cylinder research engine highly instrumented for high and low speed measurements of in-cylinder pressure, start of injection, and injection rate
- Stand alone compressor provides air to simulate turbocharging
- Independently controlled lubrication and coolant subsystems to enable isolation of combustion affecting phenomena
- Research engine includes high firing pressure capability for high power density engine research
- Flexible engine controller for choosing desired injection timing and frequency

BENEFITS

- Cell 7 has recently been utilized to study the impact of low ignition quality jet fuels on military type diesel engine combustion systems to better understand real world effects on military engines
- Cell 7 provides capability to better understand combustion in military engines and to explore various methods for reducing engine heat rejection and thus improving propulsion power density



Engine Research Testing

POC
John Hubble
john.e.hubble.civ@army.mil

PROPULSION SYSTEMS LABORATORY (PSL)

ENGINE TESTING AND DEVELOPMENT

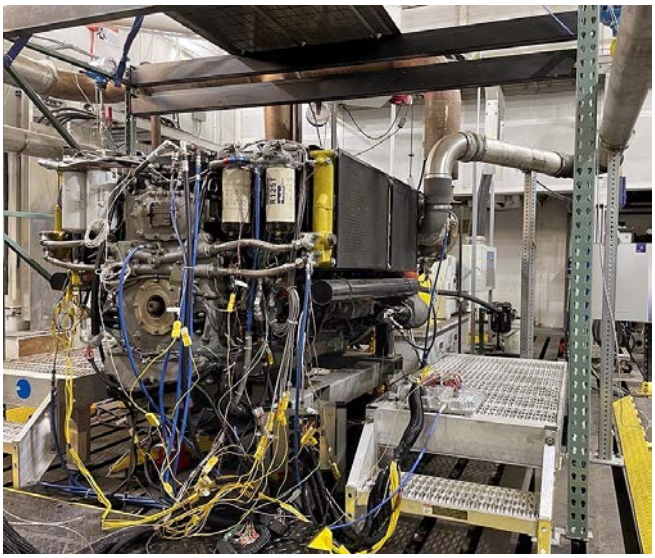
Engine Test Cells can support engine and/or transmission to complete power pack testing rated from 50 to 2000 HP. These test cells provide enhanced developmental testing in support of Army's ground vehicle fleet. Two of the test cells offer 1000 HP AC dynamometers that offer both absorption and motoring capability.

CAPABILITIES

- Engine power absorption from 50 to 2000 HP
- AC power absorption capability 200 to 1000 HP
- AC Motoring capability of 100 to 900 HP
- Controlled temperature from ambient up to 1600F
- Air velocity control from 5–20 mph
- Data collection channels up to 150 temperature, 90 analog and CAN communication capability
- Fully programmable for automated testing control, high speed data collection and channel graphing

BENEFITS

- Stable platform to test most Army tactical and combat engines and/or transmissions and power packs without changing dynamometers
- Ability to test fully mechanical to fully electronically controlled engines
- Laboratory controls multiple aspects of environmental conditions to enable reliable and repeatable testing for performance characterization, accelerated life testing and field failure replication/diagnostics



Engine Test Cells

POC
John Hubble
john.e.hubble.civ@army.mil

PROPULSION SYSTEMS LABORATORY (PSL)

POWER & INERTIA SIMULATOR (PAISI)

Test Cell 4 contains the equipment and instrumentation to operate, control and test vehicles with cross-drive type transmissions. The PAISI dynamometer system is designed to operate tracked vehicles up to 850 HP in steady state or simulated road load operational modes. Used for Bradley Fighting Vehicle and transmission performance testing. Test Cell 4 has recently been upgraded with new data acquisition and dynamometer control equipment that will further help in harvesting the critical data used to make programmatic decisions.

CAPABILITIES

- Replicates tracked vehicle loading up to 850 HP and 40 tons GVW Controlled temperature from ambient up to 160°F
- Air Velocity control from 5-20 mph
- Solar loading up to 1120 W/m2
- More than 300 data channels available for monitoring and logging data
- Project Research Development

BENEFITS

- Unique test facility for testing up to 40-ton combat vehicle propulsion system performance and durability
- Primary test cell for Bradley Fighting vehicle propulsion system integrated testing and transmission performance using road load simulation drivers
- Laboratory controls multiple aspects of environmental conditions to enable reliable and repeatable testing for performance characterization, accelerated life testing and field failure replication/diagnostics

POC
John Hubble
john.e.hubble.civ@army.mil

Power & Inertia Simulator (PAISI)

PROTOTYPE INTEGRATION FACILITY (PIF)

Detroit Arsenal (PIF) is the Arsenal's rapid response center established to engineer, fabricate & integrate technology, and develop experimental prototypes for Army watercraft, DoD ground combat & combat support systems.

PROTOTYPE INTEGRATION FACILITY (PIF)

ENGINEERED SOLUTIONS – DETROIT ARSENAL PROTOTYPE INTEGRATION FACILITY

MISSION

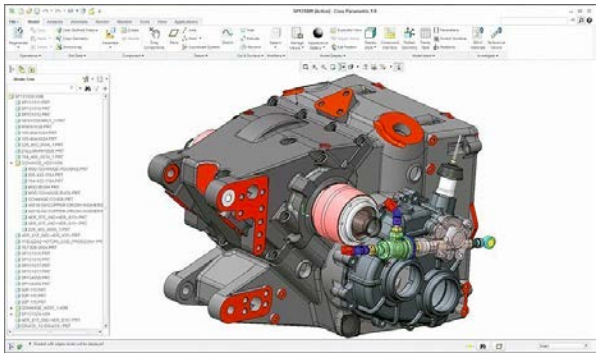
Provide the mechanical & electrical engineering expertise to the entire Detroit Arsenal, necessary for full system development or product integration onto watercraft, ground combat systems, combat service support vehicle, or logistics platforms.

OVERVIEW

Engineered Solutions Directorate is highly experienced associates capable of designing anything from individual components such as armor kits, hull structures, interiors, weapon mounts, C5ISR integration, powertrain & suspension integration, crew station integration, advanced technology integration, circuit boards, wiring harnesses, electrical cables, embedded software, as well as complete vehicular systems.

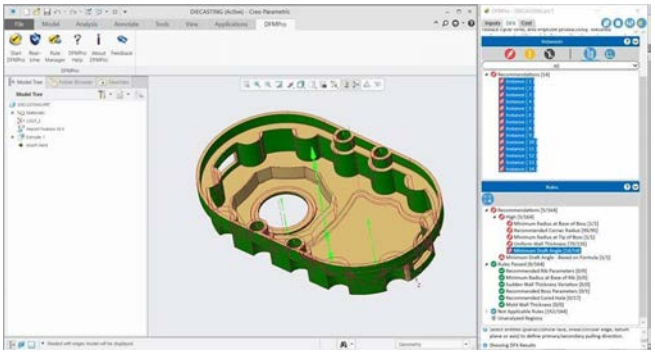
MECHANICAL ENGINEERING CORE CAPABILITIES

- 3D Solid Modeling (CREO Parametric), finite element analysis and mechanical failure analysis.
- 3D portable laser surface scanning (Handy Scan) for high measurement rates and accuracy necessary in product development and quality control.
- Concept, Developmental, and Product level drawings.
- Design for Manufacturing (DFM).
- Technical Data Packages (TDP) including engineering drawings, Bill of Materials (BOM), and user manuals.

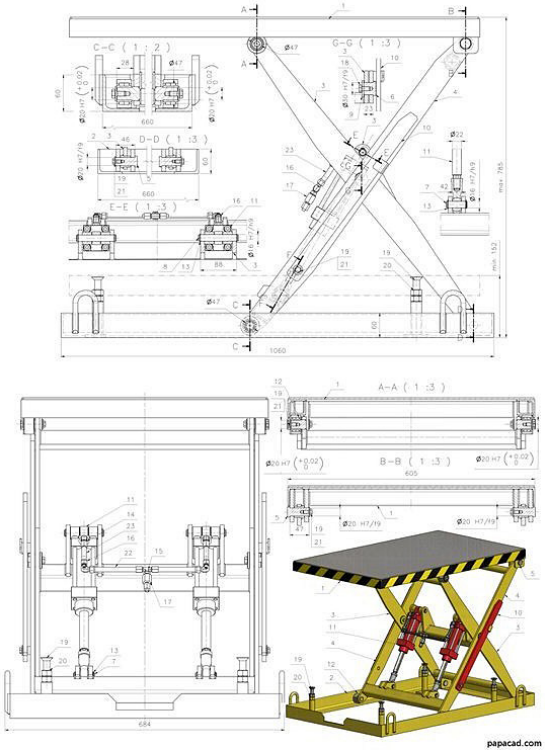


3D CAD Modeling & Analysis

3D Laser Surface Scanning



Design for Manufacturing Analysis



Technical Data Packages and Manuals

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PROTOTYPE INTEGRATION FACILITY (PIF)

ELECTRICAL ENGINEERING CORE CAPABILITIES - PRINTED CIRCUIT BOARD LABORATORY

The PCB Lab contains specialty equipment to support the fabrication of DoD grade custom prototype and production representative Printed Circuit Boards (PCBs) and Circuit Card Assemblies (CCA). The PCB Lab contains the necessary production machines to support; precise solder and flux deposition, surface and through board component placement, reflow soldering oven, solder removal, and conformal coating applications. In addition, the PCB Lab is capable of microscopic inspections and three dimensional X-Ray inspections to support quality assurance, troubleshooting, and reverse engineering activities.

BENEFITS

- Reduced developmental and production lead times for experimental/prototype PCBs and CCA
- Custom designs and components to meet specific requirements
- Integration of Nuclear Event Detection (NED) and production circuitry
- Reduced costs and lead times for external inspection sources

SPECIALTY EQUIPMENT

- Nikon X-Ray Inspection Machine
- Selective Solder Machine
- Pick & Place Machine
- Reflow Oven
- Component Remove and Replace Fixture with Microscopic Camera Assistance

Selective Solder Machine

PCB Component Pick & Place Machine

PCB Reflow Oven

3D PCB X-Ray Machine

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PROTOTYPE INTEGRATION FACILITY (PIF)

ELECTRICAL ENGINEERING CORE CAPABILITIES - CABLE & HARNESS FABRICATION LABORATORY

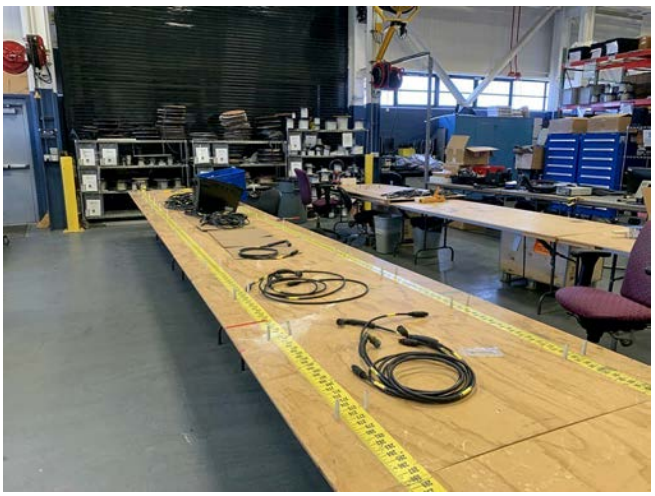
The Military Cable Lab contains specialty equipment to support the design/reverse engineering, fabrication, and quality inspection of DoD grade custom designed Cables and Wiring Harnesses. The Cable Lab contains the necessary production machines to support; precise conductor wire cutting and labeling, custom sheathing and protection coatings and looms. The laboratory is an IPC J-STD-001 and IPC/WHMA-A-620 compliant fabrication facility for military cables and wiring harnesses. The laboratory routinely performs activities to support quality assurance inspections, troubleshooting, and reverse engineering.

BENEFITS

- Reduced developmental and production lead times for experimental/prototype cables and wiring harnesses
- Custom designs to meet military specific requirements
- Continuous certification to industry standards
- Reduced costs and lead times for external inspection sources

SPECIALTY EQUIPMENT

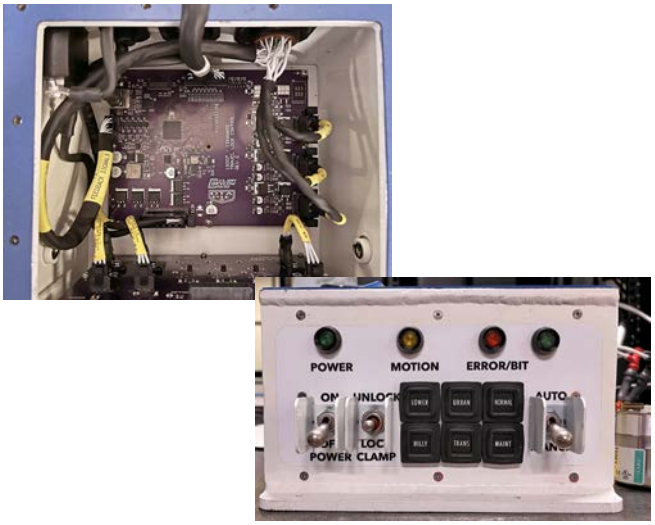
- Automated Wire Processing and Labeling Machine
- Heat Shrink Oven
- Polyethylene Loom/Braiding Machine
- Automated Contact Crimping Machine
- CIRRIS Cable Tester
- Low Pressure Over-Mold Machine



3600 sq. ft. of Cable Fabrication Space

Cirris Automated Cable Testing Equipment

MIL-STD Cable Design, Fabrication and Testing



Electrical Panel Design, Fabrication and Assembly

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PROTOTYPE INTEGRATION FACILITY (PIF)

Wire Processing, Marking, Cutting and Stripping

Automated Cable Braiding Machine

Automated Pin and Socket Crimping Machine

PROTOTYPE INTEGRATION FACILITY (PIF)

PROTOTYPE FABRICATION – DETROIT ARSENAL PROTOTYPE INTEGRATION FACILITY

MISSION

Fabricate ground system prototypes, subsystems, and components in support of modernization and readiness.

VISION

Apply advanced manufacturing techniques and “hands on” high skill craftsmanship to ensure durable, cost-effective military ground system prototypes on time and on budget.

OVERVIEW

Prototype Fabrication is where engineering solutions are realized in physical form for evaluation and delivery to customers. The highly skilled associates plan, procure and execute fabrication, integration and kitting. The integrators have experience with various Army systems. In addition, Prototype Fabrication manages a Quality Lab where parts are inspected and gages verified and calibrated.

CORE CAPABILITIES

- 19 fully customizable Integration bays; over 22,000 square feet with multiple overhead rail cranes that allow for physical integration of engineered systems and subsystems onto ground platforms
- Manufacturing process routings
- Laser and water jet cutting
- Computer numerical control (CNC) machining – Lathes and Mills
- Press Brakes
- Ballistic-certified welding and training
- Chemical Agent Resistant Coating (CARC) painting
- Kitting and Packaging
- Quality Lab with full set gages, granite slab, Romer and Faro Arm

DTA-PIF Boasts Over 140,000 ft of Fabrication, Assembly & Integration Space

Laser & Waterjet Cutting

CNC Press Brake Forming

Continued on next page...

PROTOTYPE INTEGRATION FACILITY (PIF)

CNC Machining & Turning

Ballistic-Certified Welding

Full Vehicle & Component CARC Painting

Kitting and Packaging

REAL TIME CONTROL SYSTEMS (RTCS) LABORATORY

The Real Time Control Systems (RTCS) Laboratory is a specialized developmental test facility, fully operational and equipped with engine, transmission, and powertrain component simulation capabilities for development and test of real-time control systems under low risk, controlled conditions. The RTCS Laboratory houses three hardware-in-the-Loop (HIL) test systems. By showing how application software running on an embedded controller responds in real time to all relevant signal stimuli, HIL testing provides an important contribution to quality assurance during the development and testing of application software. The HIL test systems have the capability to simulate diesel and turbine engines as well as transmissions that allow engineers to perform a variety of tests in a virtual test environment when prototype parts are available in limited numbers.

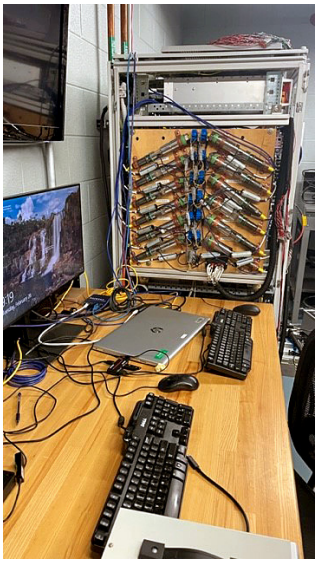
CAPABILITIES

The RTCS Laboratory houses three hardware-in-the-Loop (HIL) test systems. By showing how application software running on an embedded controller responds, in real time, to all relevant signal stimuli, HIL testing provides an important contribution to quality assurance during the development and testing of application software. The HIL test systems have the capability to simulate diesel and turbine engines as well as transmissions that allow engineers to perform a variety of tests in a virtual test environment when prototype parts are available in limited

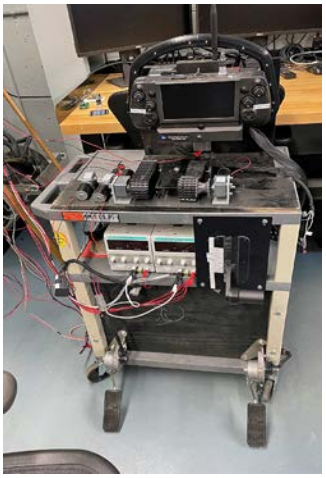
BENEFITS

- Supports development, test, evaluation, and validation of state-of-the-art embedded controller software on a system and subsystem level
- Develops advanced control systems to improve efficiency, increase capability and improve survivability of Army ground vehicles
- Aids in understanding existing and proposed control systems to support the PEOs/PMs in making acquisition decisions
- Provides highly efficient digital technologies with capabilities to increase vehicle range, mobility and efficiency

Controls Software Testing



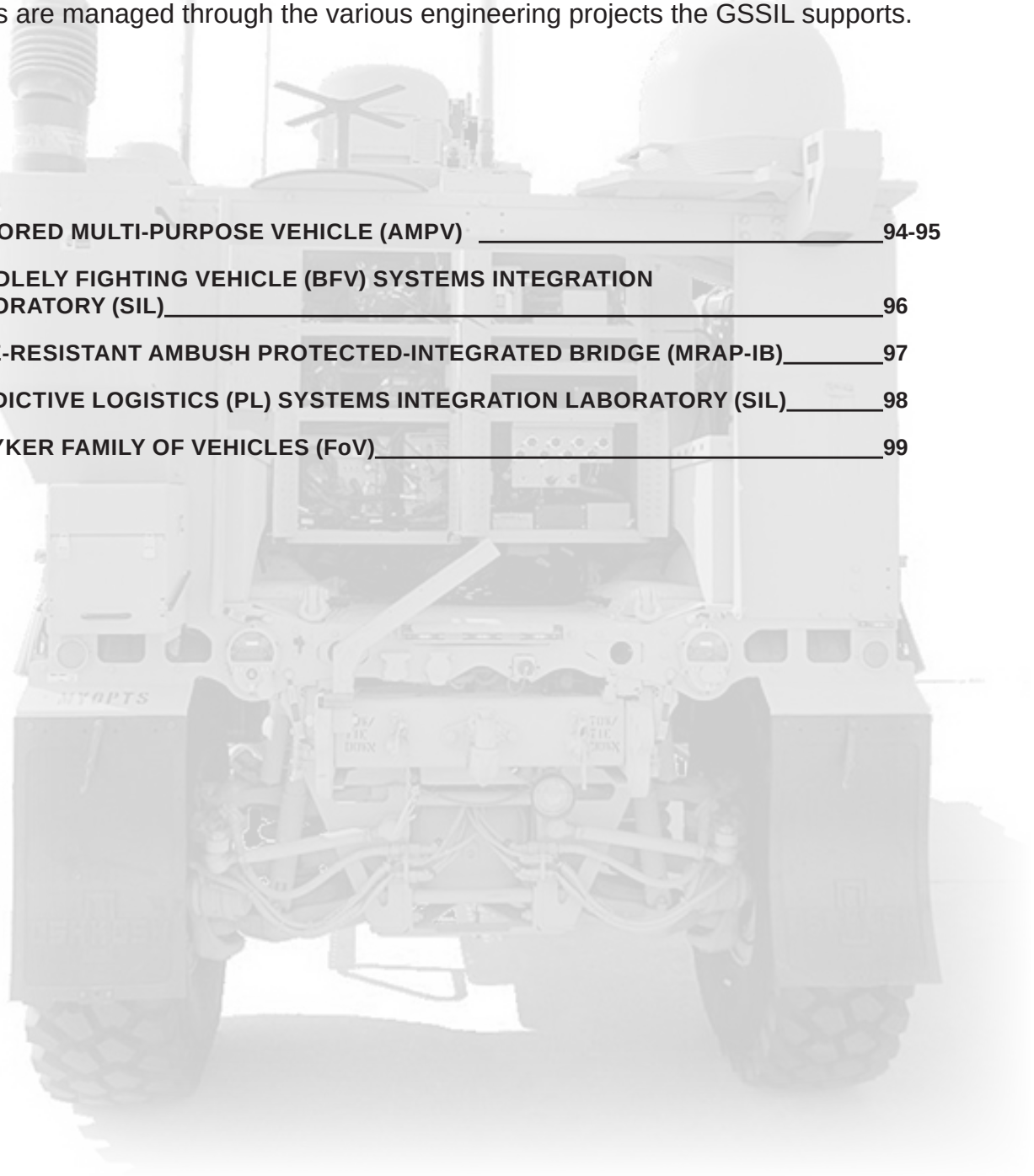
Simulated Engine Testing



Advanced Control System Development

SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

The GSSIL establishes and maintains facilities that support engineering and support activities for various programs while maintaining the associated program system, sub-system software and hardware configurations throughout all phases of the program. This includes production support, fielding, and transition to post-production program activities. GSSIL schedules and budgets are managed through the various engineering projects the GSSIL supports.



SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

ARMORED MULTI-PURPOSE VEHICLE (AMPV)

PURPOSE

Designed to operate fielded hardware, software, and cabling to recreate a vehicle inside a laboratory environment. This lab increases accessibility and adaptability to support PM MAV in integration of production software. This lab incorporates vehicle hardware (LRUs), system emulation & monitoring, radios, computers, and other equipment. The SIL team maintains a full-system bench for the Mission Command Variant and has plans to build additional benches when funding is available.

AMPV Exterior – Mission Command

BENEFITS

The GSSIL can test and verify vehicle electronics, software packages, and new cabling prior to field deployment.

The lab can also support hardware & software development, post-production support, regression testing, system training, and new technology integration & demonstrations.

SIL FEATURES AND EQUIPMENT

- Modular bench construction which can be modified to add/remove sections depending on requirements
- Two Full System Benches (Still in process ~ Estimated completion Q2 FY2024)
- One SW Mini-Bench for SW Developers to compile/package & mount vehicle SW
- Utilizes maximum GFE and MILSPEC standards (actual vehicle cabling etc.)
- Siemens Programmable Logic Controller (PLC) HW to monitor/stimulate IO
- Vector CANoE SW to stimulate discrete J1939 CANbus for emulated LRUs
- Supports MFoCS BLK II JBCP software w/ GPS and BFT2 transceivers
- Supports several MEP packages (OSRVT, M96, AFATDS, DVE-W)
- Supports VIC-3 & 5, SINGCARS, PRC-104HF and HMSII (Future)
- Support to PM for fielding issues, test procedures

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SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

Full System Bench (Mission Command Variant)

AMPV SW Mini Bench

POC
Suleiman Qandah
suleiman.s.qandah.civ@army.mil

SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

BRADLEY FIGHTING VEHICLE (BFV) SYSTEMS INTEGRATION LABORATORY (SIL)

PURPOSE

Designed to operate fielded and developmental hardware, software, and cabling to recreate a vehicle inside a laboratory environment; increasing accessibility and adaptability for rapid post-production software support and integration. This lab is comprised of full M2A3 and M3A3 BFIST vehicles, as well as a full system Virtual Test Bed (VTB) and Subsystem benches for the Turret Processer Unit (TPU).

BENEFITS

The GSSIL can test and verify vehicle electronics, software packages, and new cabling prior to field deployment. The lab can also support hardware & software development, post-production support, regression testing, system training, and new technology integration & demonstrations.

SIL FEATURES AND EQUIPMENT

- Virtual Test Bed (VTB): Allows for software regression testing in lab environment
- TPU Standalone Test Beds: Allow developers to remotely test developmental software builds
- M2A3, M3A3 BFIST Vehicles: Allow for on vehicle and track testing at GVSC and SANG

Bradley M2A3 and BFIST testing in SIL

Bradley Standalone and subsystem Benches

Bradley Virtual Test Bed

POC
Suleiman Qandah
suleiman.s.qandah.civ@army.mil

SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

MINE-RESISTANT AMBUSH PROTECTED-INTEGRATED BRIDGE (MRAP-IB)

PURPOSE

The MRAP-IB SIL is designed to operate fielded hardware and software inside a laboratory environment, increasing accessibility and adaptability for rapid post-production software support and integration. The lab incorporates vehicle hardware, system emulation, radios, computers, and other equipment; and maintains both full-system and subsystem benches for multiple MRAP variants.

BENEFITS

The GSSIL can test and verify vehicle electronics, software packages, and new cabling prior to field deployment. The lab can also support hardware & software development, post-production support, regression testing, system training, and new technology integration & demonstrations.

FEATURES AND EQUIPMENT:

- Five Full System Benches
- Multiple Sub-System Benches for development and debugging
- Test automation, Scripted Test Cases, and Test Logging
- J1939 vehicle CAN Data emulators
- WinT Inc2 and Next Gen stations
- C5ISR supported with VIC3 systems and BFT2 transceivers
- Supports JCR & MFoCS appliqués with JCR & JBCP software
- Bench configured with HMS, 117G, SINCGARS, and HF150 Radios
- Integrated hardware such as RWS, DVE, and CHK6 cameras
- In lab Hi-Bay doors with two M-ATV MRAP vehicles available

M-ATV MRAP

M-ATV MRAP rear C5ISR hardware

Test Automation and Modernization

MRAP Integrated Bridge Bench

POC
Suleiman Qandah
suleiman.s.qandah.civ@army.mil

SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

PREDICTIVE LOGISTICS (PL) SYSTEMS INTEGRATION LAB (SIL)

PURPOSE

Supports testing and verification of PL Architecture and software solutions to help drive the Army towards a viable PL solution. GSSIL continues to develop maintenance processes and procedures that improve capabilities, practices, and technologies. PL is a part of the transformation of maintenance practices from the Industrial Age to the Information Age through the appropriate use of emerging technologies to analyze near-real-time and historical systems data to provide a predictive maintenance capability with the end goal of improved fleet readiness.

BENEFITS

- End-to-end organic Army architecture to allow full-system testing and risk reduction
- Virtual computing environments to allow software testing and debug
- Flexible architecture to integrate Original Equipment Manufacturer (OEM) and/or Commercial Off-The-Shelf (COTS) PL solutions
- Expertise in Army PL software and hardware, including: Digital Logbook (DLB), Joint Technology Data Integration (JTDI) Delivery Management System (JDMS), Electronic Maintenance System (EMS) Viewer, Interactive Authoring and Display Software (IADS), Diagnostic System – VIPER (DS-VIPER), Maintenance Support Device (MSD), Wireless At-platform Test Set (WATS), Combat Service Support Automated Information System Interface (CAISI), Combat Service Support Very-Small Aperture Terminal (CSS VSAT), Digital Source Collector – Ruggedized (DSC-R)

The PL SIL's M1083 A1P2, a DLB tablet, vehicle data collectors, and spare CSS VSAT

Soldiers at National Training Center (NTC), Ft. Irwin show off their DLB tablets

POC
Suleiman Qandah
suleiman.s.qandah.civ@army.mil

SOFTWARE ENGINEERING CENTER (SEC) GROUND SYSTEMS SOFTWARE INTEGRATION LABORATORY (GSSIL)

STRYKER FAMILY OF VEHICLES (FoV)

PURPOSE

Equipped with vehicle test beds that utilize a blend of real and simulated Line Replaceable Units (LRUs), this facility offers the Army the ability to emulate real-world electrical environments for their systems. The test beds in the Stryker Lab deliver a comprehensive capacity for validating feature functionality in parallel with software development timelines. By conducting both software and hardware-level testing, Stryker Lab enhances the efficiency of in-vehicle testing, enabling early detection of bugs or faults in the software through the use of its specialized test beds. This ultimately leads to streamlined program lifecycles.

BENEFITS

Our environment allows for testing and development with full access to lab equipment prior to on-vehicle testing while still allowing for vehicle access via our High Bay Lab. Configuring hardware on bench tops allows better access, interchangeability, and modification for high use regression testing and development. Each bench can be configured for specific Stryker Variant or Mission Equipment Packages, however, benches can be linked together to form more complete Stryker systems fortesting. Most Stryker FoV Variants are represented in the Lab.

FEATURES AND EQUIPMENT

We also have multiple Benches that support common vehicle equipment such as:

- Common Chassis – equipment common to all variants such as driver instrument panels, height management units, and gauge cluster units all interconnected to operate as intended on vehicle
- C4ISR equipment – BFT & GPS data communication carts with JV5/MFoCS hardware supported by JCR/JBCP software that can be linked to other benches to replicate vehicle configurations
- Standalone Hardware/Software benches - Designed to isolate a single component for loading and verifying software and firmware

Stryker

Common Chassis Bench connected to C5ISR Cart

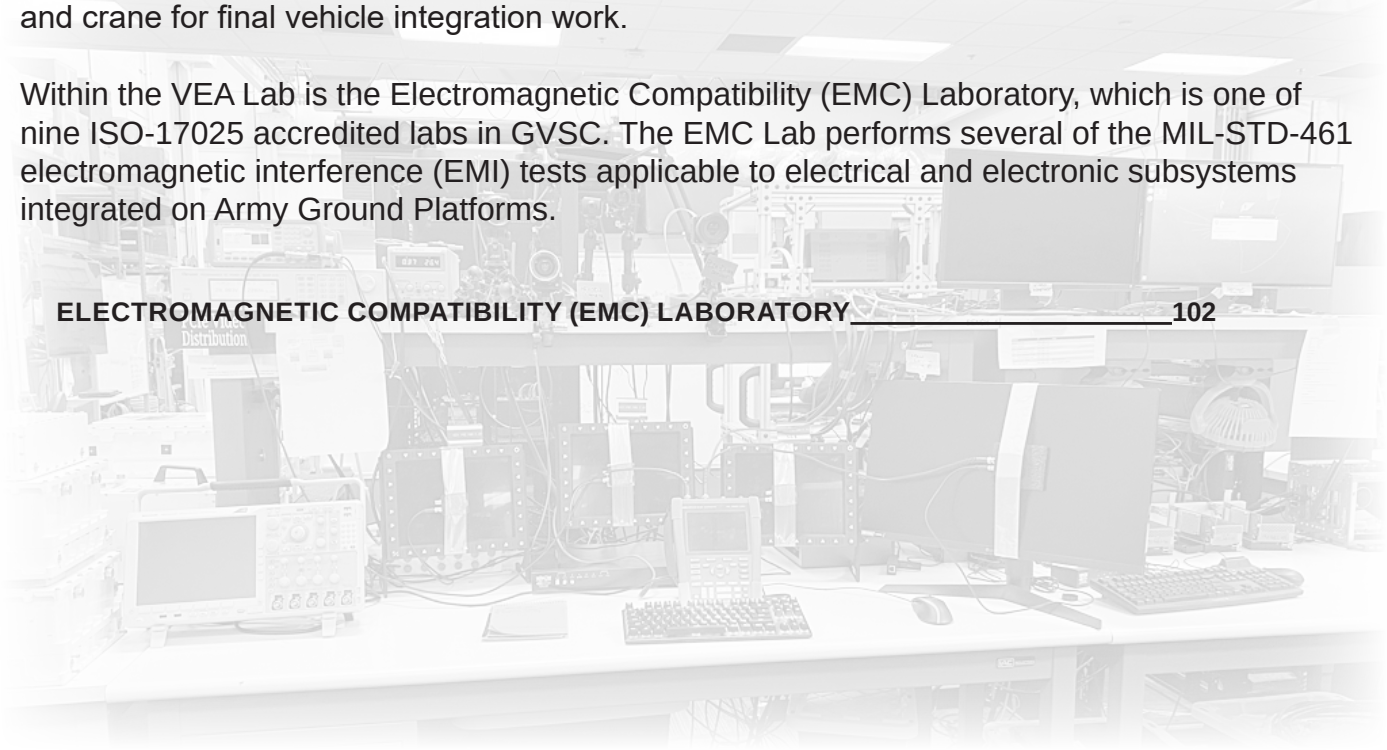
Nuclear Biological Chemical Reconnaissance Vehicle Bench

POC
Suleiman Qandah
suleiman.s.qandah.civ@army.mil

VEHICLE ELECTRONICS AND ARCHITECTURE LABORATORY (VEA)

The VEA Laboratory is used for architecture development, high-voltage (HV) power systems development, and electronics integration for tech-based Research & Development (R&D) projects. The lab utilizes several benches to conduct this development and contains a high-bay and crane for final vehicle integration work.

Within the VEA Lab is the Electromagnetic Compatibility (EMC) Laboratory, which is one of nine ISO-17025 accredited labs in GVSC. The EMC Lab performs several of the MIL-STD-461 electromagnetic interference (EMI) tests applicable to electrical and electronic subsystems integrated on Army Ground Platforms.



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VEHICLE ELECTRONICS AND ARCHITECTURE LABORATORY (VEA)

OVERVIEW

VEA's Laboratory is used for architecture development and electronics integration for tech-based R&D projects. Supports electronics and power systems development, integration and testing.

CAPABILITIES

The VEA Laboratory offers many benefits:

For High and Low voltage power components and systems including:

- Performance requirements verification
- Bench top testing
- Vehicle integration
- Performance characterization on vehicle
- Electrical power studies
- Electrical power architecture analysis

For digital network architecture, components, and systems including:

- Performance requirements verification
- Deterministic networking analysis
- Bench top testing
- Vehicle integration
- Performance characterization on vehicle
- Network bandwidth/throughput analysis
- Network load studies
- Architecture standard verification of hardware and software
- Video glass-to-glass latency testing

AVAILABLE INSTRUMENTATION

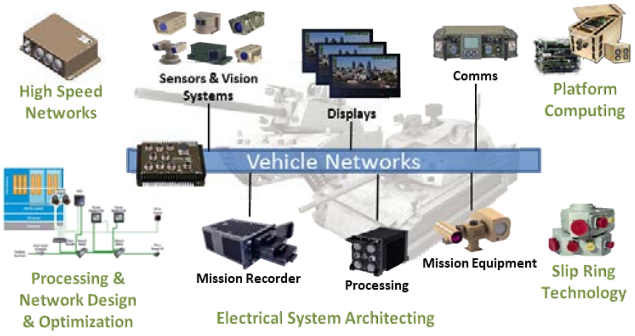
- High Voltage DC Oscilloscopes
- High voltage load banks
- Low voltage load banks
- Generator/Motor Inverter Bidirectional Test Simulator
- VDC Current Monitoring
- Ethernet analysis tool
- CAN analysis tool

POC
Philip Doherty
philip.doherty2.civ@army.mil

High Voltage Component Testing

Network Bench Top Testing

Network bandwidth/throughput Analysis Testing



Network Architecture

VEHICLE ELECTRONICS AND ARCHITECTURE LABORATORY (VEA)

ELECTROMAGNETIC COMPATIBILITY (EMC) LABORATORY

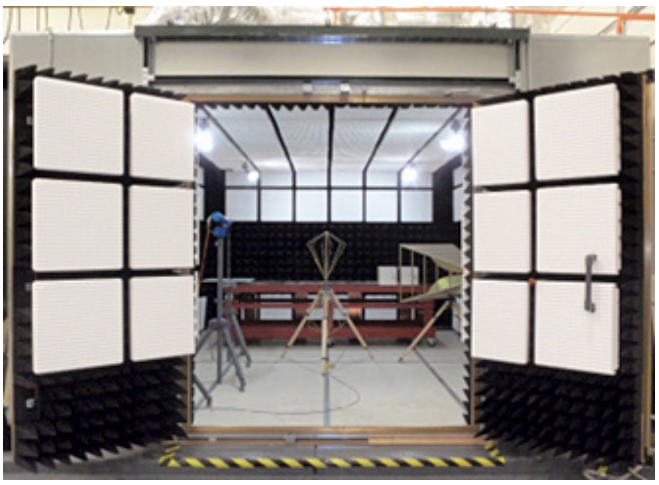
The Vehicle and Electronics Architecture (VEA) EMC Laboratory is one of nine ISO-17025 accredited laboratories in GVSC. The VEA EMC Laboratory performs several of the MIL-STD-461 electromagnetic interference (EMI) tests applicable to electrical and electronic subsystems integrated on Army Ground Platforms.

CAPABILITIES

- MIL-STD-461 Testing
  - Conducted Emissions
  - Conducted Susceptibility
  - Radiated Emissions
  - Radiated Susceptibility
- MIL-STD-464 Testing
  - Bonds and Grounds
- Testing of subsystems with 28VDC to 600VDC power
- Waveguide-below-cutoff coolant loop with thermal conditioning to support EMI/EMC testing of liquid-cooled power electronics

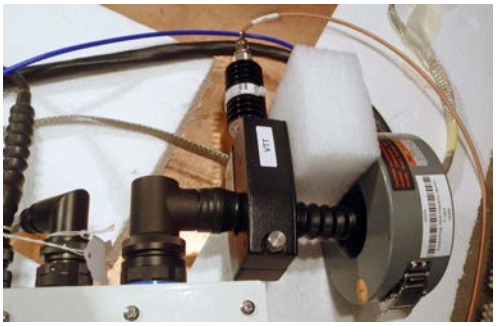
AVAILABLE INSTRUMENTATION

- Semi-anechoic 16 ft. x 20 ft. x 10. ft. shielded enclosure
- Fiber-optic closed-circuit TV, SAE J1939 (CAN) and 10/100Mbps Ethernet monitoring of equipment under test
- RF network analysis 5 Hz to 40 GHz
- Spectrum Analyzer/EMI Receivers 20 Hz to 40 GHz with Fast Fourier Transform (FFT) capability
- MIL-STD-461-compliant monopole, bi-conical, and double-ridged waveguide horn antennas for radiated emissions testing 50 Hz to 40 GHz
- Personnel-borne electrostatic discharge (ESD) to ±25 kV

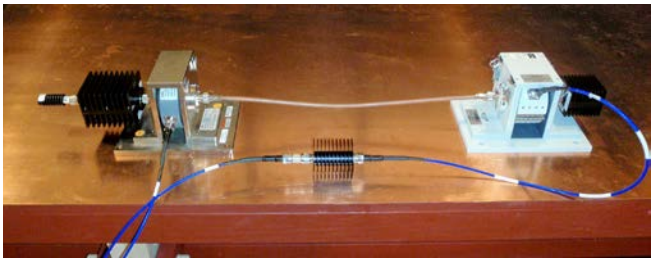


Semi-Anechoic Shielded Enclosure

Electrostatic Discharge Testing



Impulse Excitation



Bulk Cable Injection

POC
Scott W. Faust, Ph.D.
scott.w.faust.civ@army.mil

COLLABORATE WITH GVSC

The Ground Vehicle Systems Center (GVSC), located in Warren, Michigan, on the Detroit Arsenal, is the United States Army's laboratory for developing advanced military ground vehicle technologies and providing systems engineering and integration expertise that delivers unmatched ground vehicle solutions. GVSC is part of the U.S. Army Combat Capabilities Development Command (DEVCOM), a major subordinate command of the U.S. Army Futures Command.

If your organization would like to partner with GVSC, we employ several collaborative methods to engage industry, academia and other government agencies, depending upon stakeholder requirements. Some options are: Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Cooperative Research and Development Agreements (CRADAs) and Test Service Agreement (TSA).

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