



U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – GROUND VEHICLE SYSTEMS CENTER

LABORATORY TESTING CAPABILITIES BRIEFING

VITO S. SALVATO

PROGRAM MANAGER-TEST SERVICE AGREEMENTS

EXTERNAL BUSINESS OFFICE

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AGENDA



GROUND VEHICLE SURVIVABILITY AND PROTECTION

GROUND VEHICLE POWER AND MOBILITY

VEHICLE ELECTRONICS AND ARCHTECTURE

SYSTEMS SIMULATION AND TESTING

GROUND SYSTEMS CYBER ENGINEERING

FORCE PROJECTION TECHNOLOGY

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GROUND VEHICLE SURVIVABILITY AND PROTECTION (GVSP)



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SURVIVABILITY ARMOR BALLISTICS LAB (SABL)



Ground Vehicle Survivability & Protection (GVSP) is part of the U. S. Army Combat Capabilities Development Command (CCDC) Ground Vehicle Systems Center. GVSP is responsible for ground vehicle ballistic protection, blast mitigating technologies, and hit and kill avoidance initiatives for the Department of Defense. GVSP uses its unique in-house laboratories and subject matter expertise to reinforce its reputation as the Army's technical authority on survivability in the following research areas:

- Ballistics and blast testing
- Armor component fabrication and characterization
- Dynamic impact/impulse testing
- Vehicle crash and rollover assessment
- Active protection testing
- LASER and fire protection studies

The 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-3140 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
- Customer directed test plans

Transparent, metallic, and composite armor coupons and vehicle armor components are tested for:

- Research
- First Article
- Production Control



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



Samples of available projectiles

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



SURVIVABILITY ARMOR BALLISTICS LAB (SABL)

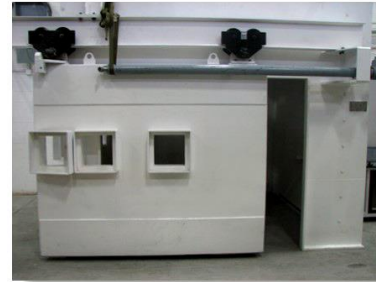


Impact Chamber

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.



Impact chamber

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



Target setup for weld evaluation testing

The SABL is an ISO 17025 accredited lab and has supported many customers including:

- | | | |
|---------------------------------|--|-------------------------------------|
| • PEO CS&CSS | • Patriot Armor Systems, LLC | • IBISTEK |
| • PEO GCS | • Technology Assessment & Transfer Inc | • Transparent Armor Solutions, Inc. |
| • SOCOM | • O'Hara Hess & Eisenhardt Armoring Company, LLC | • Hawking Glass, LLC |
| • Standard Bent Glass Corp. | • Oran Safety Glass, Inc. | • UPI Manufacturing |
| • Protected Vehicles Inc. | • PPG Aerospace | • Merrill Technologies Group |
| • BAE Systems | • Evans Manufacturing & Forming, Inc. | • Dlubak Specialty Glass Corp. |
| • General Dynamics Land Systems | • Defense Logistics Agency | |

FOR FURTHER INFORMATION:
 U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT
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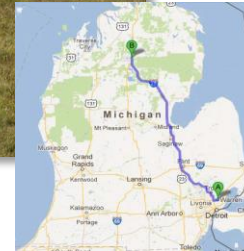


RAPID EVALUATION CAPABILITY (REC)



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REC range configurations

Description

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 over 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



RAPID EVALUATION CAPABILITY (REC)



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



FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES
DEVELOPMENT COMMAND — GROUND
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VEHICLE ARMOR LAB (VAL)



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Vehicle Armor Lab

Description

The Vehicle Armor Lab (VAL) is a multifunctional facility that focuses on the research, development, fabrication and integration of composite materials.

The VAL provides the capability to design and build composite systems for structural, armor and general vehicle applications. Using computer-aided design (CAD) software and specialized equipment, VAL engineers and technicians can rapidly fabricate custom size and custom shape composite panels.

The VAL's specialized equipment includes an automated glass/panel washing system, Computer Numerical Controlled (CNC) router, automated wet table saw, curing oven, walk-in freezer, 180 psi autoclave, and a Graco XFR Rhino-coating machine for components containing metal, glass, ceramic

or thick section composites. The two Thermotron environmental chambers enable early durability testing.

Benefits

Ability to economically design, fabricate and test prototype composite parts at a coupon, subsystem and system level to find material issues early in the development stage. In conjunction with the on-site Survivability Armor Ballistic Laboratory (SABL), armor design concepts are rapidly fabricated, evaluated or tested. Fabrication of prototype parts and early testing improves transition to full-scale production.



VEHICLE ARMOR LAB (VAL)



The VAL is a recognized leader in the Vacuum Assisted Resin Transfer Molding (VARTM) process



The VAL has one of two diamond wet saws in the country capable of cutting silicon ceramic tiles

Capabilities

- Ceramics: Capable of fabricating and integrating ceramic armor tiles with precise tolerances using a Fanuc robot.
- Composites: Extensive use of composite materials and cutting edge fabrication techniques including pre-preg autoclave-cured armor panels.
- Metals: Lightweight metals such as aluminum and titanium can be incorporated into armor designs. Capable of cutting 3" aluminum on the CNC router.

Instrumentation

- Thermal Cycling: Two ThermoTron Environmental Chambers with humidity control
- Thermocouple data recorder for accurate cure cycle feedback



The VAL is leading Army research on Transparent Armor research with an autoclave capable of adding 180 psi of pressure to a ballistic panel

FOR FURTHER INFORMATION:

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CREW COMPARTMENT UNDERBODY BLAST SIMULATOR



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- The Crew Compartment Underbody Blast Simulator (CCUBS) is 1 of 6 capabilities within the Occupant Protection Laboratory (OPL). OPL is a full service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems. 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.



Computer Animated Design of CCUBS

- GVSP continues to increase the OPL's in-house testing capabilities, ISO certifications, and offsite testing support with the addition of new test equipment and resources to support physical testing efforts.
- The Crew Compartment Underbody Blast Simulator (CCUBS) is a pneumatically-actuated test device with a large platform capable of holding up to four seated occupants, and used to evaluate vehicle crew compartments in simulated underbody blast events. CCUBS simulates the independent local and global forces that occur from an underbody explosive event (initial vertical and drop-down forces). This test device helps to evaluate occupant protection technologies and integrated components' effects on occupants in a controlled, repeatable, and reproducible environment. 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.



SUB-SYSTEM DROP TOWER



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- The Sub-System (SSDT) is one of six capabilities within the Occupant Protection Laboratory (OPL) is a full service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems. 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.
- GVSP continues to increase the OPL's in-house testing capabilities, ISO certifications, and offsite testing support with the addition of new test equipment and resources to support physical testing efforts.



Energy Absorbing Seat Test

- The SSDT is a test 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.



SUB-SYSTEM DROP TOWER



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



Cargo Retention Test

Available Instrumentation

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



Ammo Rack Retention Test

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND —
GROUND VEHICLE SYSTEMS CENTER: <https://tardec.army.mil/>

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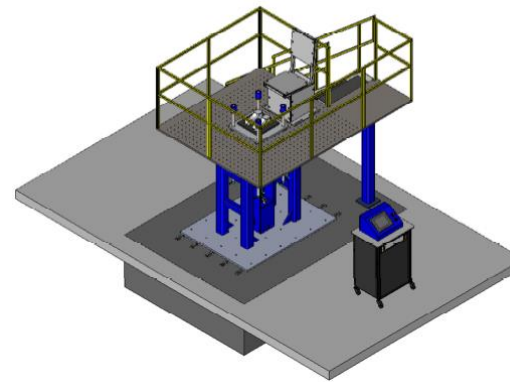
FLOOR INTERFACE TECHNOLOGY ACCELERATOR



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- The Floor Interface Technology Accelerator (FITA) is one of six capabilities with the Occupant Protection Laboratory (OPL). OPL is a full service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems. Stakeholders use the OPL to perform unique "out of the box" impact testing as well as standardized testing on occupant protection and energy mitigation technologies.
- GVSP continues to increase the OPL's in-house testing capabilities, ISO certifications, and offsite testing support with the addition of new test equipment and resources to support physical testing efforts.



Computer Animated Design of FITA

- The FITA is an impact system used to evaluate the performance of energy absorbing floor materials, boots, etc simulating an underbody blast's effects on a Soldier's lower extremities. It can be adapted to test the effects of an impact on any component' subjected to high 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 OPL test fixtures or in live-fire events.



FLOOR INTERFACE TECHNOLOGY ACCELERATOR



FITA



ATD Seated In Position

Capabilities

- 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'x2'

Available Instrumentation

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

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND —
GROUND VEHICLE SYSTEMS CENTER: <https://tardec.army.mil/>

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ANTHROPOMORPHIC TEST DEVICE CERTIFICATION LAB



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- The Anthropomorphic Test Device (ATD) Certification Lab is 1 of 6 capabilities within the Occupant Protection Laboratory (OPL). OPL is a full service test facility with the resources, capabilities, equipment, and partnerships needed to perform dynamic impact/impulse testing on components, subsystems, or systems. 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.
- GVSP continues to increase the OPL's in-house testing capabilities, ISO certifications, and offsite testing support with the addition of new test equipment and resources to support physical testing efforts.



Thorax Impact Test Device

- The OPL's ATD Certification Lab enables GVSC to efficiently certify ATDs in-house. This capability reduces the time and cost of certifying ATDs and reduces downtime between testing. ATDs are certified frequently increasing the confidence, reliability and repeatability for each test event.
- This ATD certification services are available to our stakeholders.

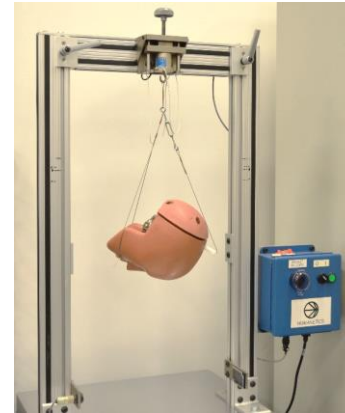


ANTHROPOMORPHIC TEST DEVICE CERTIFICATION LAB

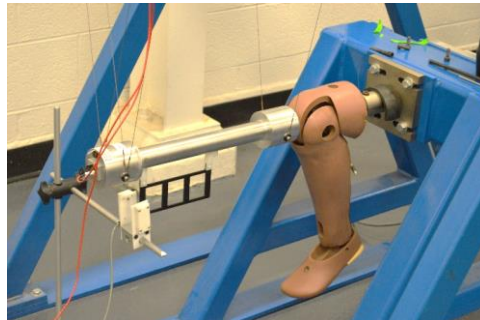


Capabilities

- Compliant with CFR 49, Part 572 ATD
- Instrumentation conforms to SAE J211 standards
- Multiple Hybrid III ATDs available representing 5th, 50th, 95th Soldiers as well as several WIAMan (Warrior Injury Assessment Manikin) systems
- Test fixtures to specifically certify each body region of an ATD: head, neck, knee, thorax, and foot.



Head Drop Test Device



Knee Impact Test Device



Neck Pendulum Test Device

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND —
GROUND VEHICLE SYSTEMS CENTER: <https://tardec.army.mil/>

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FIRE PROTECTION TECHNOLOGY INTEGRATION LAB (FP TIL)



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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 provides CCDC 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





FIRE PROTECTION TECHNOLOGY INTEGRATION LAB (FP TIL)



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

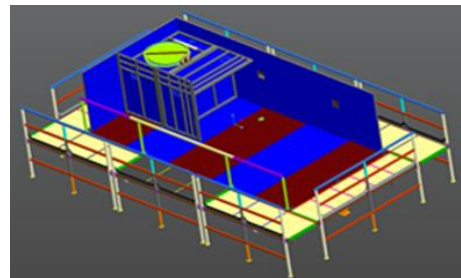
Research

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

Special Features



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.

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: CCDC 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.

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES
DEVELOPMENT COMMAND — GROUND
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SENSOR PROTECTION LABORATORY



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Laser Dazzle

GVSP's Sensor Protection Lab provides engineers and scientists the ability to characterize the performance of vision, optical, LIDAR and their response to LASERS as well as investigate ways to protect eyes and sensors from LASER energy.

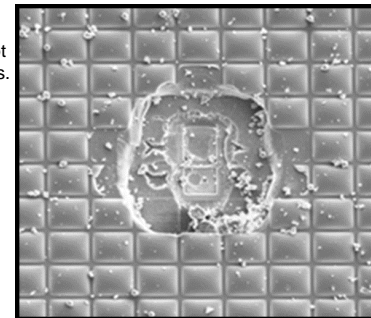
Benefits

Concepts developed in this lab add to the overall capabilities of the Army to protect mounted Soldiers' day vision -- via eye OR sensor -- from various forms of LASER energy.

GVSP is currently working to improve sensor protection technologies and adapt them to multiple ground vehicle platforms. In addition, engineers and scientists are continuously developing and testing new materials, devices, and strategies to deliver counter advanced LASER technologies.

Capabilities

- Material Evaluation
- Optical System Evaluation
- Hardware Design/Fabrication
- Technology Integration
- Filter Certification



Camera Sensor LASER Damage



SENSOR PROTECTION LAB



End Users of the Laser Lab:



Collaboration Partners:



FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES
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GROUND VEHICLE POWER AND MOBILITY (GVPM)



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GVSC's Ground Systems Power and Energy Laboratory (GSPPEL) 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. 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.

GSPPEL Testing Capabilities

Testing Services

- 250 to 12,000 SCFM air flow test benches with zero to 4X zero visibility dust feed for air filters, cleaners and equipment testing
- Up to 50,000 CFM air flow for heat exchanger (radiator), charge air and oil coolers, and armored ballistic grille characteristics/performance testing
- High-voltage/power components testing for vehicle electrification and hybrid electric power tech integration
- ISO 17025 LQMS accredited test lab for production qualification of batteries and electrochemical technology testing at cell, module and battery pack levels
- Controlled and repeatable road profile simulated full vehicle powertrain testing to create, assess and validate vehicle design, functionality and utility





Air Flow Laboratory

- Calorimeter Testing
- Filtration Testing
- Replicate field failures
- Assess maintenance efficiency
- Evaluate new heat exchangers and ballistic grilles



Electrical Components Laboratory

- Testing of high voltage, high power components
- Analyze future electrical power generation
- Variable coolant temperature and flow rate over a large range
- Pressure testing of coolant cooled components using high sensitivity pressure transducers



Energy Storage Laboratory

- Assess performance of fielded storage system
- Test new solutions for fielded and future vehicle systems
- Multiple cell/battery Cyclers on a centralized control system
- Thermal Chambers and temperature controlled Water Baths



Power & Energy Vehicle Environmental Laboratory

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



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Air Flow Laboratory



GSPCL Laboratory

GVSC's Ground Systems Power and Energy Laboratory (GSPCL) 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 surveillance

Components Tested

- Radiators
- Oil Coolers
- Charge Air Coolers
- Ballistic Grilles



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

Components Tested

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



AFL Filtration Test



Capabilities

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



Radiator Test Setup



Ballistic Grille Test Setup

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

2000 CFM Bench

- Air Flow Rate: 800 to 12000 SCFM



12,000 CFM Test



2,000 CFM Test Setup



2,000 CFM Test Setup



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Electric Component Laboratory



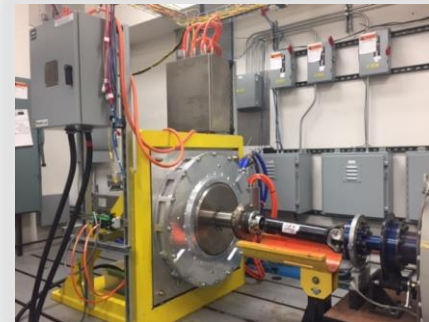
GSPEL Laboratory

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



160kW Integrated Starter Generator



SiC Inverter

Components Tested

The ECL can test multiple types of components:

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



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

AC and DC Load Banks

- Up to 250kW power absorption

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



250kW Resistive Load Bank



FOR FURTHER INFORMATION:
Phone: (586) 215-9327

Igor Baseski, Lab Manager
e-Mail: igor.baseski.civ@mail.mil



Energy Storage Laboratory



GSPEL Laboratory

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 and temperature controlled Water Baths.



Internal Cell/Module Test Rooms

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.



Cell, Module & Battery Cycling Equipment



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	4	8	±54VDC	±.05VDC	±100ADC	±.1ADC	-40 to 190°C	±2.5°C
Bitrode	LCV4-100-60	7	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 150°C	±.5°C	1.5 ft ³	5°C/min	5°C/min
ESPEC	BTZ-475	5	-65 to 150°C	±.5°C	4 ft ³	2.5°C/min	2.75°C/min
Cincinnati Sub-Zero	ZPHS-8-1.5-1-H/AC	1	-65 to 150°C	±.5°C	8 ft ³	14°C/min	17°C/min
Tenney	T10RC-1.5	3	-65 to 150°C	±.3°C	10 ft ³	4°C/min	5.5°C/min
Russells	GD-64-5-5-AC-EP	1	-65 to 150°C	±1°C	64 ft ³	3°C/min	3.8°C/min
Thermotron	SE-2000-6-6	1	-65 to 150°C	±.7°C	69.3 ft ³	3.4°C/min	5.3°C/min
Water bath	-	2	15 to 70°C	±1°C	up to 15.7 ft ³ *	≈.2°C/min	≈.25°C/min

*Depth of water can vary from 4 to 17"



Outdoor Pack Test Chambers



FOR FURTHER INFORMATION:
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PEVEL

GSPCL Laboratory

GVSC's Ground Systems Power and Energy Laboratory (GSPCL) 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/m²

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



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: 0-1250 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



FOR FURTHER INFORMATION:
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VEHICLE ELECTRONICS AND ARCHITECTURE (VEA)



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OPSEC #:



ELECTROMAGNETIC COMPATIBILITY TEST FACILITY



Vehicle Electronics and Architecture (VEA) is part of The U. S. Army Ground Vehicle Systems Center (GVSC). VEA is responsible for the development of open architectures for combat vehicles to manage data, video and power systems to enable future combat vehicle capabilities such as advanced protection, lethality, and network systems.

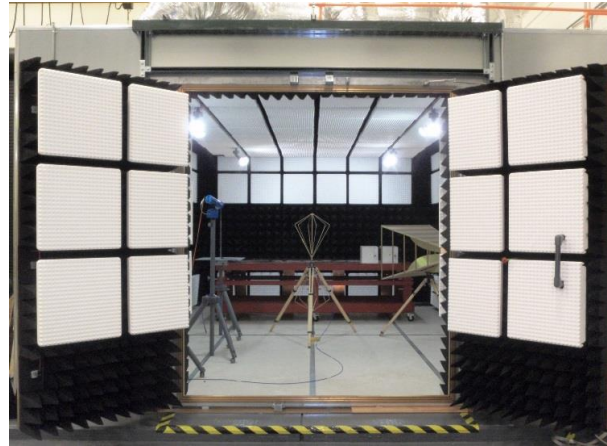
VEA uses its unique in-house laboratories and subject matter expertise to reinforce its reputation as

the Army's technical authority on vehicular electronics and architectures in the

following areas:

- Vehicular Integration for C4ISR/EW Interoperability (VICTORY)
- Power Management and Architectures
- Standardization of Open Power and Data Architectures and Vehicle System Control Software

- The Electromagnetic (EMC) Test Facility is a test capability located within the System Integration Technologies (SIT) Laboratory. The SIT Laboratory provides the resources, capabilities, and equipment needed to support development of system architectures, high-voltage (HV) power electronics, and EMC testing of electrical/electronic sub-systems and components.



- VEA continues to increase the SIT Laboratory's in-house capabilities through the pursuit of laboratory accreditation to ISO 17025, support of Design for EMC reviews, recommendations for EMC mitigation components, finite-element method (FEM) computational electromagnetics analysis, and participation in leadership of the TACOM Electromagnetic Environmental Effects Requirements Board (E3RB).
- VEA's EMI Chamber is semi-anechoic, and rated to 18 GHz with inner dimensions (less absorber) of 16 ft. x 20 ft. x 10 ft. It is lined with a combination of TDK IS-045, IS-030A and IS-B-10 flat sheet absorber. It is equipped with a high voltage (HV) feedthrough panel rated to $\pm 750\text{VDC}$ and 400ADC, fiber-optic closed-circuit TV and SAE J1939 CAN bus monitoring, and waveguide-below-cutoff to support EMC testing of liquid-cooled power electronics.

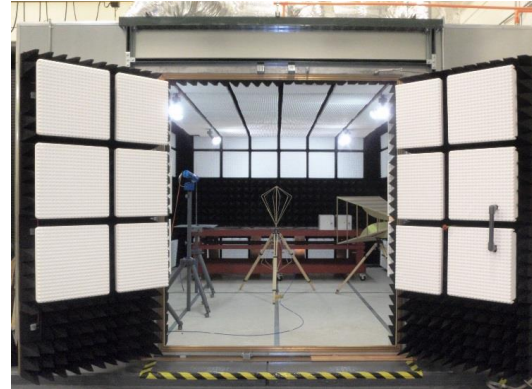


ELECTROMAGNETIC COMPATIBILITY TEST FACILITY



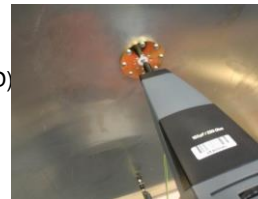
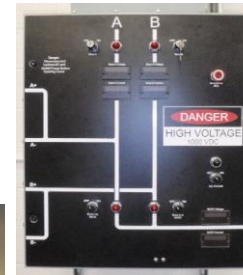
Capabilities

- MIL-STD-461 Revision G Testing
 - Conducted Emissions CE102
 - Conducted Susceptibility CS101, CS114, CS115, CS116, CS118
 - Radiated Emissions RE102
 - Radiated Susceptibility RS101
- MIL-STD-464 Revision C Testing
 - Bonds and Grounds



Available Instrumentation

- RF network analysis 5Hz to 40GHz.
- Spectrum analyzer/EMI Receiver 20Hz to 40GHz.
- Monopole, bi-conical, and double-ridged waveguide horn antennas for radiated emissions testing from 50 Hz to 40 GHz.
- Personnel-borne electrostatic discharge (ESD) simulation to ± 25 kV.



FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND —
GROUND VEHICLE SYSTEMS CENTER: <https://tardec.army.mil/>

Scott W. Faust, Ph.D. | scott.w.faust.civ@mail.mil
Phone: (586) 282-4608



SYSTEMS SIMULATION AND TESTING



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GROUND VEHICLE SIMULATION LAB



The Ground Vehicle Simulation Lab (GVSL) is a component of the Army Ground Vehicle Systems Center (GVSC).

The GVSL is responsible for supporting Test and Evaluation (T&E) at the vehicle and component level. GVSL has the capability to provide strategy to innovatively test for performance and reliability of ground systems, and mitigate risks associated with the deployment of ground systems, while ensuring timely focus on reliability and maintainability requirements. Some key competencies of GVSL are:

- TRL Maturation
- Requirements Testability
- TEMP Development
- Subsystem integration
- Developmental and Operational test management
- Engineering Change Validation

CAPABILITIES

- The GVSL has a wide range of capabilities that fits a large selection of vehicles and components
 - N-Post testing
 - Heavy Vibration
 - Light Vibration
 - Trailer testing
 - Suspension and blast Characterization
 - Environmental Chambers
 - Mass property simulations
 - Suspension property simulation
 - Component durability and characterization
 - Tire durability and characterization
 - Torsion bar testing





Vehicle N-Post Testing

Vehicle Capacity

- Up to 5-axle wheeled vehicles
- Up to 12-road-wheel tracked
- Up to 80,000 GVW

Actuators

- (8) -38 kip, 20 inch stroke
- (8) -25 kip, 20 inch stroke
- (4) -11 kip, 12 inch stroke
- (5) -11 kip, 14 inch stroke



Analysis Capabilities

- Fatigue Damage Estimation
- Statistical Time History Editing
- Cycle Counting Analysis
- Data Acquisition
- Ability to record several channels on various on-going experiments
- In-house and portable field data acquisition systems
- Acceleration, Strain, Rotational Rate, and Displacement



Vehicle N-Post Testing

Data Acquisition

- Ability to record several channels on various on-going experiments
- In-house and portable field data acquisition systems
- Acceleration, Strain, Rotational Rate, and Displacement

Benefits

- 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.





GROUND VEHICLE SIMULATION LAB



Mission Equipment Vibration Table (MEVT)

Mounting Surface

- Table size: 101" x 120" [8.4' x 10']
- 6" rectangular grid spaced $\frac{3}{4}$ " x 10 mounting holes

Vibration Table Motion Limits

- Displacement: Vertical = ± 4 in
- Rotational
 - Roll = ± 6 degrees
 - Pitch = ± 6 degrees
- Velocity: Vertical = 18 in/s (0.4572 m/s)
- Acceleration: Vertical = 10g
- System Bandwidth (bare table) = 100 Hz @ 25,000 lbs
- Maximum Payload = 25,000 lbs





GROUND VEHICLE SIMULATION LAB



Mission Equipment Vibration Table (MEVT)

Benefits over Field Testing

- Repeatability: Can reproduce previous test conditions
- Test Compression: Removal of non-damaging events
- Control Environment: Motions do not change with time, due to driver, weather, test parameters, etc.
- Reproduction of Field Environment: Measured field responses can be replicated
- Dynamic qualifications of vehicle subsystems by applying single or multiaxial base excitation and identifying modal properties.





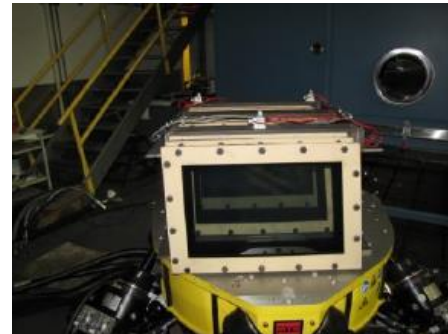
Multi-Axial Simulation Table (MAST)

Benefits

- Dynamic qualifications of vehicle subsystems by applying single or multi-axial base excitation to identify modal properties.
- Extensive range of applications designed to integrate early stage development with flexibility to provide meaningful information that will minimize cost and accelerate subsystem development.
- MIL-STD-810G Vibration Testing.

Mounting Surface

- Table with Octagon shape: diameter of 1 m
- Octagon grid spaced 100 mm x 100 mm mounting holes





Ground Vehicle Simulation Lab

Multi-Axial Simulation Table (MAST)



Vibration Table Motion Limits

- Displacement
 - Vertical = ± 37 mm
 - Longitudinal, Lateral = ± 35 mm
- Rotational
 - Roll = ± 4.7 degrees
 - Pitch = ± 4.2 degrees
 - Yaw = ± 3.5 degrees
- Velocity
 - Vertical = 0.8 m/s
 - Longitudinal, Lateral = 0.6 m/s
- Acceleration
 - Vertical = 20.6 g
 - Longitudinal = 14.8 g
 - Lateral = 12.8g
- System Bandwidth (bare table) = 500 Hz @ 1,080 lbs
- Maximum Payload = 500 kg (1080 lbs)





Ground Vehicle Simulation Lab



Pintle Motion Base Simulator (PMBS)

Application

- Structural Testing of Design Prototype
- Comparison Testing
- Component Failure Analysis
- Characterization

Benefits

- Laboratory trailer testing offers the repeatability of dynamic events, and can eliminate performance variables such as weather conditions, driver variability and course maintenance.
- Extensive range of application design to integrate early stage development with flexibility to provide meaningful information that will minimize costs, accelerate development and compress test schedules.
- Provides a high-fidelity, multiaxial simulator that provides experimental test conditions for finite element analysis.

The PMBS is used to conduct durability and performance tests on lunette trailers. It provides motion and force inputs to the test trailer's tires and lunette to reproduce dynamic conditions experienced at proving grounds.





Ground Vehicle Simulation Lab



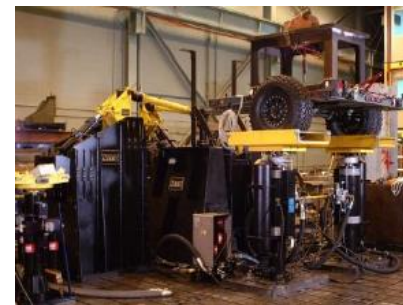
Pintle Motion Base Simulator (PMBS)

Axial Displacement

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

Maximum Force

- Lunette
 - Vertical = $\pm 18,000$ lbs
 - Lateral = $\pm 11,700$ lbs
 - Longitudinal = $\pm 27,300$ lbs
- Tires-Vertical: = $\pm 25,000$ lbs
- System Bandwidth
 - Lunette: 40 Hz
 - Tires: 60 Hz
- Maximum Payload = 20,000 lbs





Ground Vehicle Simulation Lab



Shock Test Evaluation Machine (STEM)

Actuator

- Force Rating: 192 KN (43,000 lbs)
- Dynamic Displacement: ± 7 in
- Velocity: 8 m/s

Analysis Applications

- Force versus Displacement Characteristics
- Force versus Velocity Characteristics
- Peak Force versus Peak Velocity Characteristics
- Temperature Effects
- Rebound and Compression Force
- Rebound and Compression Velocity
- Rebound and Compression Spring Rate
- Gas Force
- Elastomer Material Calculations:
 - Dynamic Stiffness
 - Storage Stiffness / Tan Delta
 - Loss Stiffness
 - Phase / Dampening





Ground Vehicle Simulation Lab



Blast Analytical Test System (BATS)

Actuator

- Force Rating: 307 KN (69,000 lbs)
- Dynamic Displacement: ± 8 in
- Velocity: 11 m/s

Applications

- Blast Analysis
- Reactional Mass
- Sub Component Suspension
- Quarter Car Testing
- Seat Blast Characterization
- Armor Blast Characterization
- Floor Blast Mat Characterization

Benefits

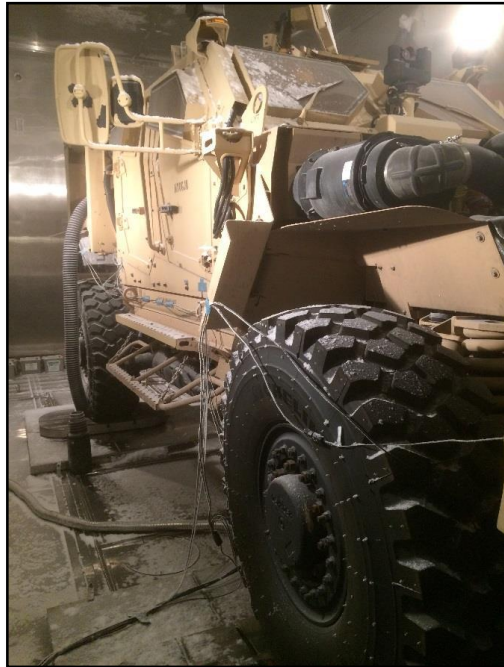
- Accepts all forms of dampener systems used in the Army's ground vehicle fleet today.
- Conducts extreme velocity and force tests and evaluations on a fully integrated vehicle corner suspension system.





Vehicle Environmental Chamber

- Dimension
 - Length: 371 in (30 feet)
 - Width: 186 in (15.5 feet)
 - Height: 180 in (15 feet)
- Temperature Capability
 - Range: -50°F to 185°F
 - Humidity Range: 20% to 95%
 - Humidity Limitations: -40°F dew point at maximum dry-bulb temperature at 149°F





Ground Vehicle Simulation Lab

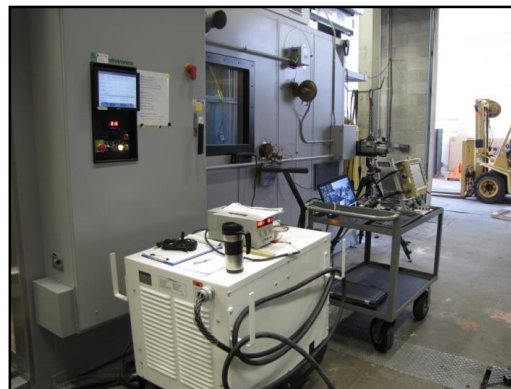


MAST Environmental Chamber

- Dimension
 - Length/Width/Height: 72x72x72 in
- Temperature Capability
 - Range: -60°F to 195°F
 - Humidity Range: 20% to 95%

Environmental Test Chamber

- Dimension
 - Length: 108 in
 - Width: 60 in
 - Height: 80 in
- Temperature Capability
 - Range: -65°F to 195°F
 - Humidity Range: 20% to 95%
- Maximum Payload 2000 lb





Vehicle Inertial Properties Evaluation Rig (VIPER)

Capabilities

- The VIPER is capable of determining various parameters including vehicle COG, mass moments of inertia, total vehicle weight and roll/yaw mass product of inertia.

Benefits

- 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.
- The VIPER directly impacts vehicle design trade-off , rollover analysis/prediction, vehicle stability/handling/ride, turret drive/control, transportability assessments, suspension tuning/design, vehicle data plate information and analysis





Ground Vehicle Simulation Lab



Vehicle Inertial Properties Evaluation Rig (VIPER)

Capacity

- Vehicle Weight (1,500 –100,000 lbs.)
- Vehicle Width (up to 150 in.)
- Vehicle Length (up to 600 in.)

Accuracy

- CG Positions $\pm 1\%$
- Moments of Inertia $\pm 3\%$
- Weight and Axle Load ± 1 lb.

Parameters Measured

- Vehicle Center of Gravity
- Mass Moments of Inertia in Roll
- Mass Moments of Inertia in Pitch
- Mass Moments of Inertia in Yaw
- Roll/Yaw Mass Product of Inertia
- Axle Loads
- Total Vehicle Weight





Suspension Parameter Identification Evaluation Rig (SPIdER)

Capacity

- Vehicle Weight (up to 100,000 lbs.)
- Vehicle Width (up to 150 in.)
- Vehicle Length (up to 600 in.)





Ground Vehicle Simulation Lab



Suspension Parameter Identification Evaluation Rig (SPIdER)

Parameters Measured

- Suspension Force versus Deflection
- Spring Force/Deflection (Jounce/Rebound)
- Shock Force/Velocity Deflection (Jounce/Rebound)
- Tire Force versus Deflection
- Jounce Damping Characteristics
- Rebound Damping Characteristics
- Roll Center
- Roll Steer
- Suspension Roll Moment versus Roll Angle
- Suspension Roll Damping versus Roll Velocity
- Suspension Rebound Direction Spring Force versus Deflection Curve
- Measured at the Wheel
 - Suspension Jounce Direction Spring Force versus Deflection
- Curve Measured at the Wheel
 - Frame Twist Deflection/Rigidity Evaluation
 - Auxiliary Roll Stiffness





Uniaxial Tension/Compression Testing (Riehle/Instron)

Riehle Actuator

- Force Rating: 300,000 lb
- Dynamic Displacement: 48 in
- Velocity: 0.5 in/min (0.0002 m/s)

Analysis Capability

- Force versus Displacement Characteristics
- Force versus Velocity Characteristics
- Peak Force versus Peak Velocity Characteristics
- Ultimate Strength Testing
- Durability Testing
- Material Properties

Benefits

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





Uniaxial Tension/Compression Testing (Riehle/Instron)

Analysis Capability

- Dynamic Stiffness
- Storage Stiffness
- Loss Stiffness
- Phase
- Dampening
- Tan Delta

Actuator

- Force Rating: 115,000 lb
- Dynamic Displacement:
10 in
- Velocity: 1118 in/min
(0.5 m/s)





Tire Test Machine

Machine Performance

- Top Speed: 60 MPH
- Maximum Load: 30,000 lb
- Wide Drum Wheel : 36 in
- Camber/Yaw: ± 5 degree
- Inflation/ Deflation System

Applications

- Measure Tire Rolling Resistance
- Measure Tire Drag Force
- Torque Measurement
- Perform Protocols:
 - SAE J1269
 - SAE J2452
 - ISO 18164
 - ISO 28580
- Measurement
 - Longitudinal Load, Fx: 20,000 lb
 - Lateral Load, Fy: 20,000 lb
 - Normal Load, Fz: 20,000 lb
 - Brake Torque, My: 47,000 ft-lb
 - Rolling Resistance Load, Fx: 200 lb





Tire Test Machine

Benefits

- Conducts comprehensive tests of rim and tire characteristics under a wide range of duty-cycle and environmental conditions, providing the most accurate simulation of real-world usage available in North America.
- Captures the resulting data for later use in computer M&S studies.
- To match Tire Test Machine testing capabilities, a manufacturer would need to drive from Texas in August to Alaska in January, and back; even then, the data captured would not be as comprehensive.





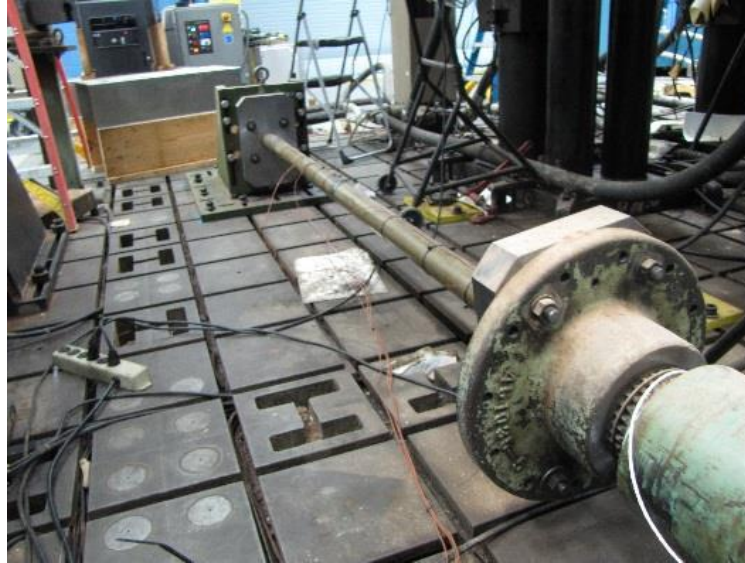
Rotary Actuator –Torsion Bar Testing

System Performance

- Up to 60 Cycles per Minute
- Test Torsion Bars up to 15 feet
- Rotary angle driven testing or torque driven testing

Rotary Actuator Specifications

- Solid Shaft Double Vane Rotary Actuator
- Up to $100^{\circ} \pm 5^{\circ}$ of total rotation
- Up to 62,000 ft-lb Torque at 3,000 psi





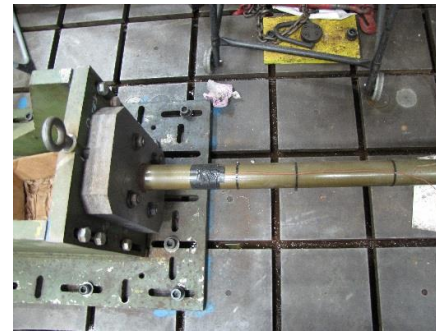
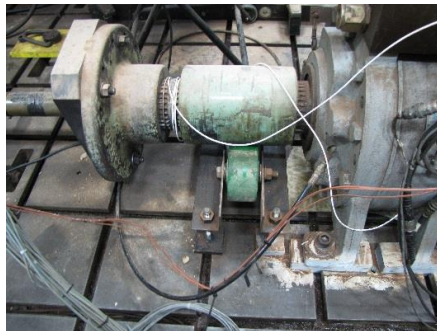
Rotary Actuator –Torsion Bar Testing

Analysis Capabilities

- Durability Testing for Fatigue Damage or Failure
- Statistical Time History Editing
- Cycle Counting Analysis
- Data Acquisition
- Ability to record several channels on various on-going experiments
- Characterize torque, angle, spring rate, and permanent set.

Data Acquisition

- Ability to record Temperature, Strain, Rotational Rate, Torque, and Rotational Angle
- In-house and portable field data acquisition systems





GROUND SYSTEMS CYBER ENGINEERING



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OPSEC #:



GROUND SYSTEMS CYBER ENGINEERING (GSCE)



MISSION:

Develop, integrate & sustain the right technology solutions for all manned & unmanned DoD ground systems & combat support systems to improve current force effectiveness & provide superior capabilities for the future force.

VISION:

Be the first choice of technology & engineering expertise for ground vehicle systems & support equipment - today & tomorrow.



Priorities

- Ensure cyber resiliency for new ground vehicle systems
- Mitigate “Critical” vulnerabilities in fielded systems
- Secure the Hardware and Software System Architectures

U.S. ARMY COMBAT CAPABILITIES
DEVELOPMENT COMMAND –
GROUND VEHICLE SYSTEMS

<https://tardec.army.mil>

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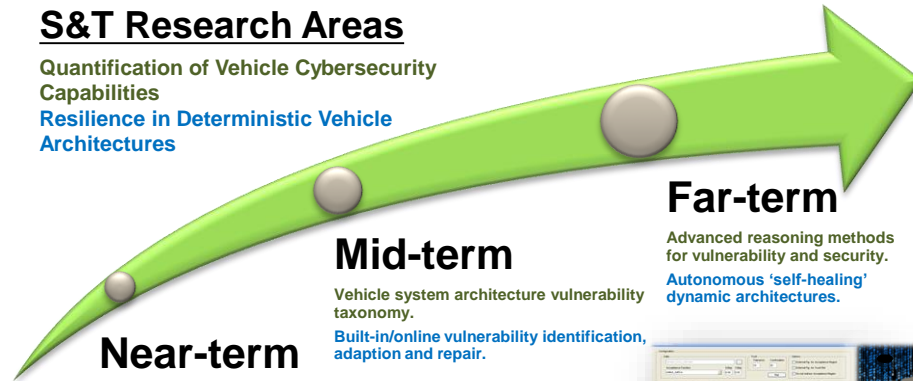
GROUND SYSTEMS CYBER ENGINEERING (GSCE)



S&T Research Areas

Quantification of Vehicle Cybersecurity Capabilities

Resilience in Deterministic Vehicle Architectures



Near-term

Measurement, analysis and verification methods for vehicle architectures.

Simulation toolsets to design and 'virtually' test potential safeguards and solutions of the vehicle architecture

Mid-term

Vehicle system architecture vulnerability taxonomy.

Built-in/online vulnerability identification, adaption and repair.

Far-term

Advanced reasoning methods for vulnerability and security.

Autonomous 'self-healing' dynamic architectures.



Baking security into the vehicle architecture will significantly reduce the cyber attack surface.

Over the next 5 to 10 years, ground vehicle architectures will become more distributed with:

- The continuous development of ubiquitous sensing
- High-speed and cloud-based computation and data-transfer networks/buses
- Machine-based reasoning
- App-based access to "big data"

To offset evolving security challenges, risks against adversarial cyber attack effects must be addressed early in the Lifecycle and continuously monitored.

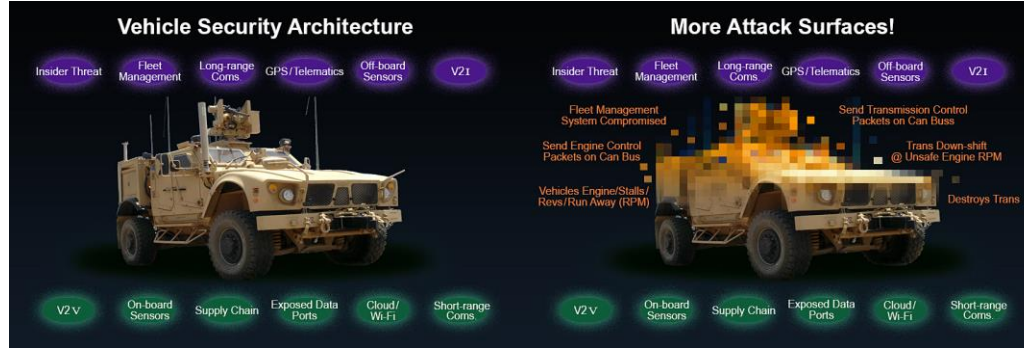
U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – GROUND VEHICLE SYSTEMS

<https://tardec.army.mil>

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GROUND SYSTEMS CYBER ENGINEERING (GSCE)



Ground Systems Cyber Engineering (GSCE) Capabilities:

- Cyber assessment of weapons platforms
- Full Vehicle Cooperative Test (Blue Team)
- Experienced Penetration Testing Using Real World Vectors
- Component(s) Bench Testing
- Hardware Reverse Engineering
- Software Assurance
- Firmware Integrity Verification
- Data Anthropology
- Cyber Security Consulting Services
- Cyber governance mated to mission needs and objectives
- Validation of Security Controls
- Cost/benefit analysis of having cybersecurity practices built in from the start of a project
- Strategic formulation regarding cybersecurity
- Program / system vulnerability scans with a variety of tool options
- Mission assurance engineering assessments
- Oversight of cybersecurity risk management from a holistic viewpoint
- Ensured assessment and authentication (A&A) for tactical information systems
- Advanced research to improve cybersecurity in future systems
- Vulnerability Research
- Initial cyber resiliency assessment

A holistic approach to cybersecurity from project inception to decommission

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FORCE PROJECTION TECHNOLOGY (FPT)



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OPSEC #:



WATER TREATMENT & HANDLING LABORATORIES



Water Research Laboratory (WRL) and Water Treatment Test Facility (WTF) 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 U.S. Army Combat Capabilities Development Command (CCDC) Ground Vehicle Systems Center's (GVSC) Water Treatment and Handling Equipment (WTHE) team 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 the treatment, storage, distribution and quality analysis of water on the battlefield.

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

GVSC also has access to the Seawater Desalination Test Facility, located at and operated by the Naval Facilities Center (NAVFAC), Port Hueneme, CA. The Seawater Desalination Test Facility capabilities are comparable to the WTF 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

DoD Lead Laboratory for Ground Water Supply & Wastewater Treatment per DOD 4705.01 and AR 700-136



RO Element Test Stand



Lightweight Water Purifier outside WTF



WTF Classroom

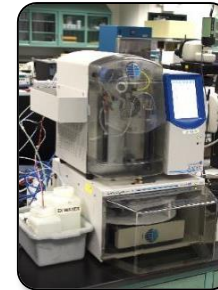


WATER TREATMENT & HANDLING LABORATORIES



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



Total Organic Carbon Analyzer

Features and Equipment

- Heated indoor boat well 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
 - Inline 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 disconnections
 - Exterior concrete pad at water's edge
 - Conference room seating for up to 25



Pretreatment Test Stands



Water Quality Test Stand

The Water Treatment and Handling Laboratories maintain unique capabilities within the **U.S. Army CCDC 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

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND — GROUND VEHICLE SYSTEMS CENTER:

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BRIDGE TECHNOLOGY LABORATORY



The Bridge Technology Laboratory is located at Selfridge Air National Guard Base (SANGB), Harrison Township, MI. The lab is designed to conduct strength and durability testing of military bridges. It is capable of evaluating bridging components, subassemblies and complete systems in simulated environments. The lab offers unobstructed access to test fixtures within the building and storage of large bridge components outside of the building when they are 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

TARDEC's Bridge Technology Laboratory can support testing for complete bridges or structures up to 210' long, 32' wide and 23' high. The lab contains 10 hydraulic actuators that can 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

ISO 17025 Accreditation

Accredited to perform Structural Strength Testing

- Loads up to 1,000,000 lbs.
- Displacement up to 24"
- Dimensional outside diameter up to 6" and inside diameter between 0.7" - 6"



Assault Bridge under test



High-speed feedback controller



Material handling equipment device load test





BRIDGE TECHNOLOGY LABORATORY (BTL)



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 inside before moving outside
- Material handling equipment includes forklifts and man lift capable of lifting up to 475 lbs. a maximum height of 42'
- Some limited fabrication (mill, lathe, weld, etc.) available onsite



Long semi-permanent tactical bridge

Load Control System

- 10 Computer-Controlled Hydraulic Cylinders
 - 36" Stroke
 - 100,000 lbs. each
- Deflection Safety Limits
- Lateral Safety Limit Switches
- 2500 PSI Pressure, 100 gallons per minute (gpm) Flow

Data Acquisition System

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

The Bridge Technology Laboratory maintains unique capabilities within the **U.S. Army CCDC 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.

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND — GROUND VEHICLE SYSTEMS CENTER:

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FUELS & LUBRICANTS LABORATORY (FLL)



The U.S. Army Combat Capabilities Development Command (CCDC) Ground Vehicle Systems Center's (GVSC) Ground System Performance Fluid (GSPF) team operates and maintains the Fuels and Lubricants Labs (FLL). The FLL has the ability to conduct research, development, testing, analysis, and investigation of ground system performance fluids. Lab experts adhere to standardized testing methodology as published by ASTM International, SAE International, and Federal Test Method 791.

Mission: Tackle those unique challenges facing ground system performance fluids to keep the U.S. military in motion anytime, anywhere.

Vision: To be DOD's premier choice in technological development and cutting edge research of performance fluids and material interactions in ground systems.

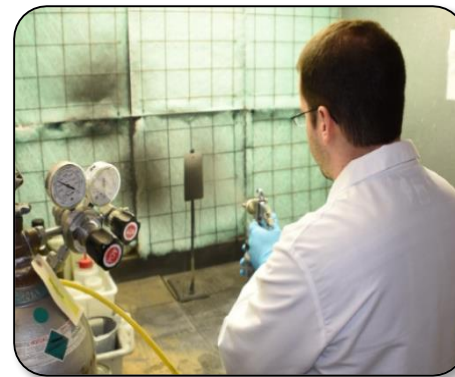


GSPF serves as the Department of Defense's responsible agent for all ground fuels and lubricants specifications: AR70-12 – Fuels and Lubricants Standardization Policy for Equipment Design, Operation, and Logistic Support

CCDC GVSC's Fuels and Lubricants Labs comprise 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.



GSPF Chemical Engineer examining particulate contamination in fuel.



GSPF Research Engineer preparing steel panels for solid film lubricant testing.



FUELS & LUBRICANTS LABORATORY (FLL)



GSPF Products & Capabilities

Capabilities include:

- Combustion and Volatility
- Physical Properties
- Elemental Properties
- Stability and Cleanliness
- Flow/Rheology
- Tribology
- Elastomer Compatibility
- Corrosion Prevention
- Ancillary Equipment

	Fuel	Engine Oil & Trans. Fluid	Gear Oil	Solvent	Hydraulic Fluid	Coolant	Grease	Solid Film Lubricant	Brake Fluid	Preservative Oil	Filters & Debris
Combustion & Volatility	●	●		●	●					●	
Physical Properties	●	●	●	●	●	●			●	●	
Elemental Properties	●	●	●	●	●	●	●	●	●	●	●
Stability & Cleanliness	●	●	●		●	●			●	●	●
Flow & Rheology	●	●	●		●	●			●	●	
Tribology	●	●	●		●	●	●	●	●	●	●
Elastomer Compatibility	●				●		●		●		
Corrosion Prevention	●				●	●	●	●		●	
Research	●	●	●	●	●	●	●	●	●	●	●

ISO 17025 Accreditation

Accredited to perform 45 ASTM test methods on fuel and oil.



Benefits:

- Independent government analysis, testing and interpretation of results.
- Government and industry interface.
- Prompt testing supports in-house TARDEC projects, especially in conjunction with GSPEL testing.
- Historical background on products.
- Development of custom products and associated specifications and documentation for procurement.

GSPF maintains unique capabilities within the **U.S. Army CCDC 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.

For questions related to ground system fluids, contact usarmy.detroit.rdecom.mbx.tardec-pol-help@mail.mil

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND — GROUND VEHICLE SYSTEMS CENTER:

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U.S. ARMY PETROLEUM LABORATORY



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. Products tested include 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 electronically



Filter Effectiveness Testing



Bulk Petroleum Testing



Accredited to perform 51 ASTM
test methods on
fuel and packaged petroleum products



U.S. ARMY PETROLEUM LABORATORY (APL)



Fuels Laboratory

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

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.
- Assists with crash investigations
- Assists with laboratory certification and correlation programs of fixed and deployable Army petroleum laboratories
- Evaluates products for new EPA requirements
- Evaluates the day to day operational issues associated with POL products

The Army Petroleum Laboratory maintains unique capabilities within the **U.S. Army CCDC 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.

FOR FURTHER INFORMATION:

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND — GROUND VEHICLE SYSTEMS CENTER:

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