



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

Ground Systems Power & Energy Laboratory

Capabilities Overview

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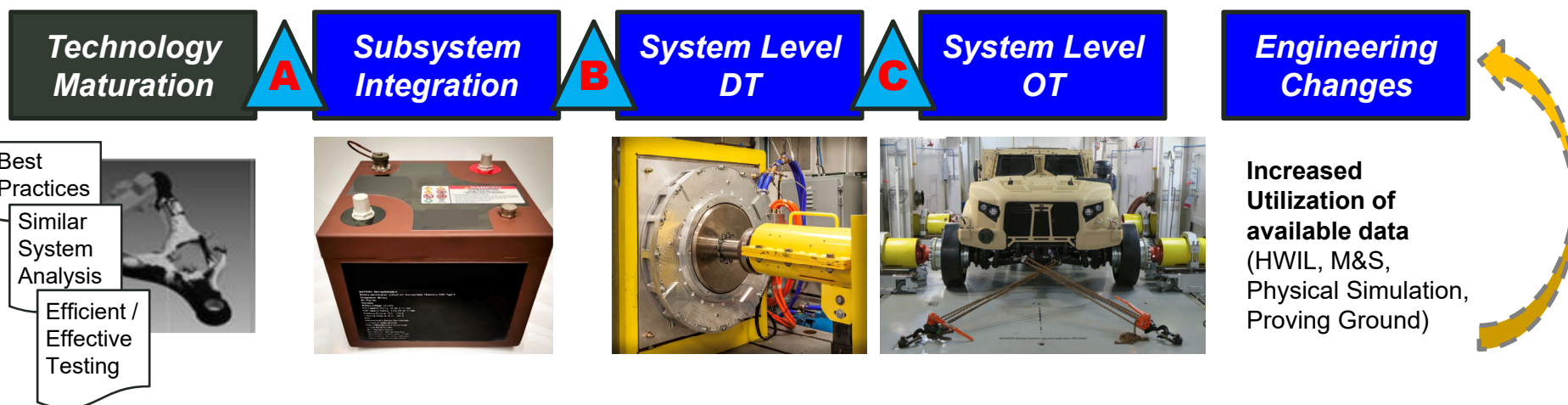
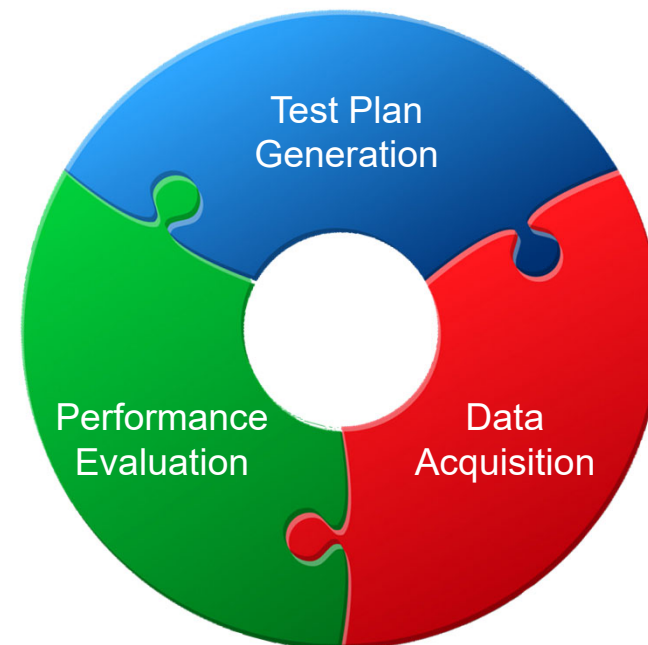


Test & Evaluation Support



Purpose: Manage, develop, and support integrated life cycle Test and Evaluation (T&E) services. 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.

- **TRL Maturation**
- **Requirements Testability**
- **Subsystem Integration**
- **Developmental/Operational Test Management**
- **Engineering Change Validation**
- **T&E Efficiencies**





Ground Systems Power and Energy Laboratory (GSPEL)



The GSPEL is the Army's Centerpiece Laboratory for full vehicle environmental mobility testing, power and energy research and development, integration, and component testing. The GSPEL is composed of five laboratories that provide one-of-a-kind test support to current and emerging classes of ground military and commercial vehicles, wheeled and tracked, manned and unmanned.



- **Air Flow Laboratory - Air Filtration Benches**

- ❑ The Air Flow Laboratory (AFL) - Filtration Benches provide dust testing of air filtration devices to demonstrate and validate new or legacy system capabilities in a controlled environment.

- **Air Flow Laboratory – Calorimeter**

- ❑ The Air Flow Laboratory (AFL) – Calorimeter provides testing of military vehicle heat exchangers to evaluate their cooling capacity, air restriction, and coolant restriction as well as military vehicle ballistic grilles to evaluate their air restriction in a repeatable, controlled environment.

- **Electrical Components Laboratory**

- ❑ The Electrical Components Laboratory (ECL) tests high-voltage/power components for vehicle electrification and hybrid electric power technology integration..

- **Energy Storage Laboratory**

- ❑ The Energy Storage Laboratory (ESL) provides testing for production qualification of batteries and electrochemical technology testing at cell, module and battery pack levels.

- **Power & Energy Vehicle Environmental Laboratory**

- ❑ The Power & Energy Vehicle Environmental Laboratory (PEVEL) tests multi-wheel or tracked military vehicles with road-load simulation under extreme environmental conditions.



Air Flow Laboratory



Air Flow Laboratory (AFL) supports the execution of component level testing on several critical mobility systems on a variety of military vehicles by use of the Calorimeter and Air Filtration Benches.





Air Flow Laboratory



Calorimeter Testing

Benefits

- Evaluate new heat exchangers and ballistic grilles
- Repeatably 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
- Expedites the development process for vehicle engine and transmission cooling systems

Components Tested

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



AFL Calorimeter Test

Air Filtration Testing

Benefits

- Evaluate new air cleaner systems
- Replicate field failures
- Assess impact of add-on parts to air cleaner systems
- Evaluates proposed vehicle maintenance efficiencies
- Unbiased first-article dust test and production quality surveillance
- Troubleshoots failures of current fielded systems.
- Provides first-article dust testing before vehicle implementation.

Components Tested

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



AFL Filtration Test



Air Flow Laboratory



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

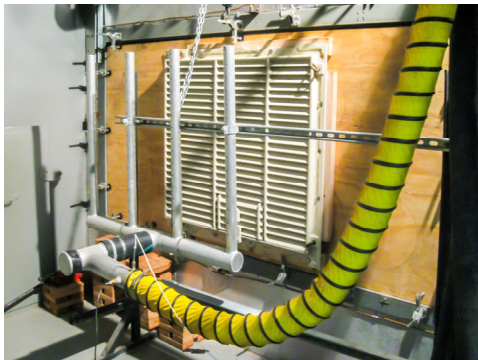
- Coolant Flow Rate: 10 to 300 gal/min
- Coolant Inlet Temperature: 125 to 350 ° F
- Coolant Inlet Pressure: 0 to 125 psig

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





Electrical Components Laboratory



The Electric Components Laboratory (ECL) 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 control, and 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.



ECL - Cell 10



Electrical Components Laboratory



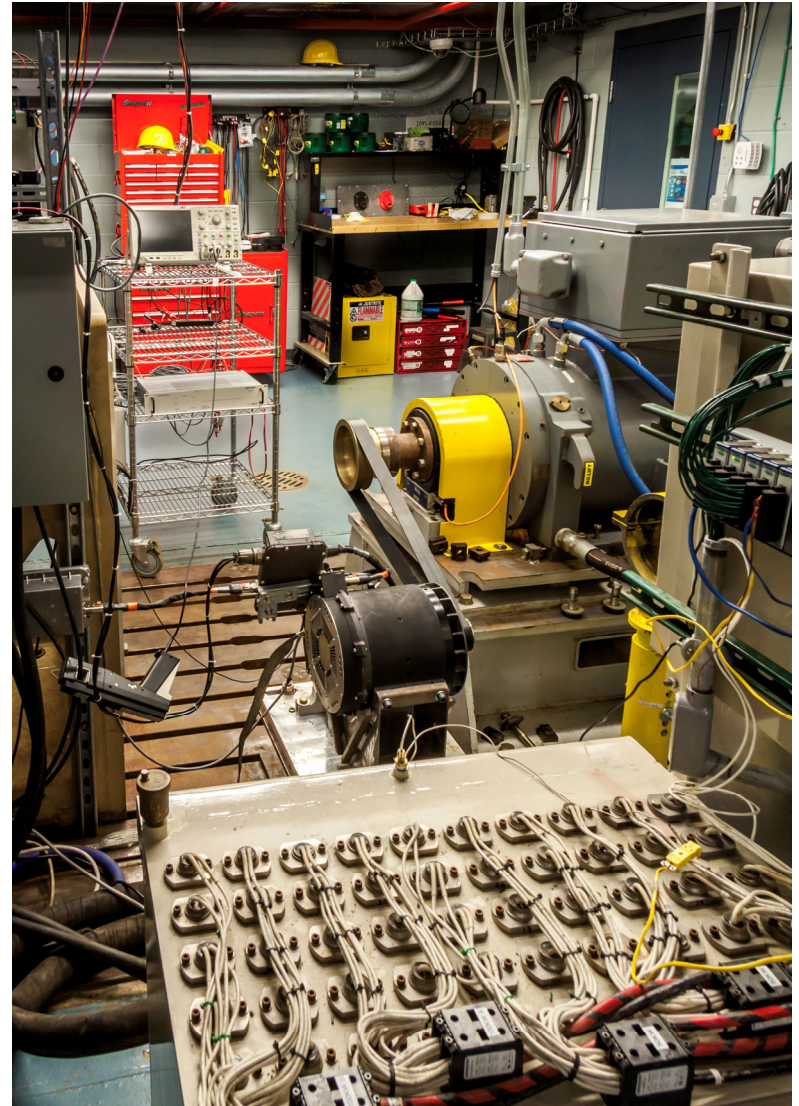
Benefits

- 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:

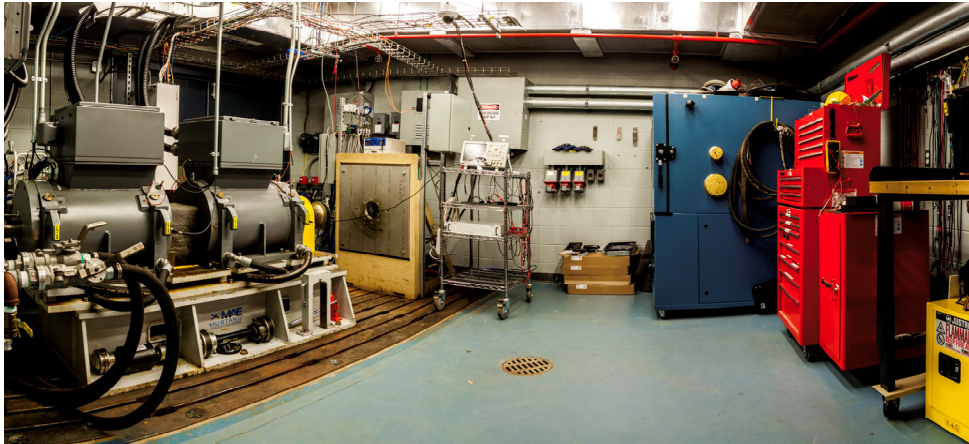
- Advanced Electric Machines
- High Voltage Alternators
- Motor controllers
- Power Inverters
- DC/DC Converters



Nihoff Alternator 600VDC



Electrical Components Laboratory



ECL Main Laboratory

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

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



ROBOTIC – POWER & ENERGY VEHICLE ENVIRONMENTAL LABORATORY



The R-PEVEL is a standalone laboratory, dedicated to testing the power and mobility of robotic platforms. The Lab provides for environmental control of robotic test assets, and features two dynamometers and control systems to thoroughly test drivetrain components of prototype and fielded robotic systems.

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

Dynamometer Specifications

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

Environmental Control

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



Energy Storage Laboratory



The Energy Storage Laboratory (ESL) evaluates and qualifies batteries and other electrochemical technologies at the cell, module and battery pack levels. The ESL also uses an Electrochemical Analysis and Research Laboratory (EARL) housed within the Propulsion Lab. Provides evaluation capabilities for ground vehicle energy storage systems



ESL - Control Room



Energy Storage Laboratory



Capabilities

The ESL is comprised of three large battery test rooms, two test chambers and storage rooms.

Multiple cell/battery cyclers on a centralized control system, thermal ovens and temperature controlled water baths support a variety of electrochemical tests.

The EARL has battery and cell cycler equipment that can test up to 50 V modules at charge or discharge currents up to 200 A with temperature controls ranging from minus 37° C to 177° C.

Three (3) large Battery Test Rooms, two (2) Pack Test Chambers, an Electrochemical Research Lab, and a Battery Management System Lab.

Benefits

- Aids in assessing technical readiness levels (TRLs), understanding new technologies and supporting the PEOs when determining whether systems are ready for fielding.
- Provides warfighters with solutions for fielded and future systems.
- The EARL can test manufacturer performance claims on battery products and provide usable data for design purposes.
- Test new solutions for fielded and future vehicle systems.
- Provides cradle-to-grave research and testing support for all DoD ground vehicle energy storage systems.
 - Performance to specification
 - Cycles to Failure (Service Life)
 - Cold Cranking
- Assess performance of fielded storage systems.



ESL - Cell 103



ESL - Cell 105



Energy Storage Laboratory



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"



ESL - Outdoor Battery Chambers



Power and Energy Vehicle Environmental Lab



The Power and Energy Vehicle Environmental Laboratory (PEVEL) offers tools for vehicle powertrain assessment. Equipped with multiple dynamometers, the PEVEL provides the tools required for full vehicle powertrain testing, evaluation and assessment of both wheeled and tracked vehicles through external load control and data collection. PEOs/PMs, manufacturers, academics and researchers can use these tools to create, assess and validate vehicle design, functionality and utility in a fully controlled and repeatable environment.



PEVEL - Bradley



Power and Energy Vehicle Environmental Lab



Capabilities

The PEVEL chamber enables testing at temperatures from -60°F to 160°F and humidity levels from 5 to 95% relative humidity. This environmental control makes it possible to produce, repeatable, real-world vehicle performance and capability comparisons. Simulation of wind speed up to 60 mph and solar load up to 1,200 watts/per square meter (W/m²). Vehicle drivetrain loads of wheeled vehicle with torque up to 34,000 pound-foot (lb-ft) and of tracked vehicle torque up to 42,000 lb-ft can be provided. Additionally vehicle electrical power loads up to 800 kW can be simulated. Compatible fuels for testing in the PEVEL include hydrogen, Diesel, JP-8, F-24, bio-diesel and synthetic blends.

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



PEVEL - M109A7

Benefits

- Functions as a test-bed to evaluate vehicle system performance in any operational environment.
- Allows for testing in extreme climates under various loads.
- Performs repeatable tests on components or vehicles, producing real-world vehicle and component performance/capability comparisons.
- Functions as a systems integration laboratory (SIL); fully supports hardware-in-the-loop simulation.
- Addresses the testing gap for multi-axle wheeled vehicles and provides additional evaluation capabilities for vehicle on-road performance.



Power and Energy Vehicle Environmental Lab



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

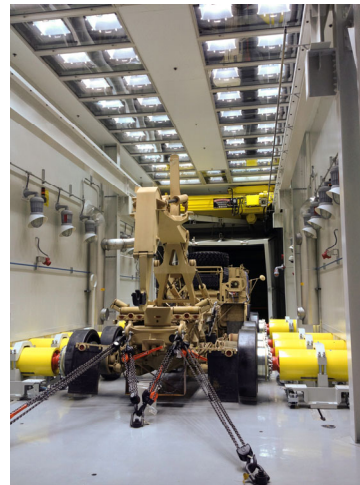
- Temperature: - 60°F to 160°F
- Wind: 0 to 60 mph
- Solar: 0 to 1,200 W/m²
- Humidity: up to 95% RH

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



PEVEL - PLS



PEVEL - M109A7



FOR FURTHER INFORMATION:

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GSPEL Website:

<http://www.usarmygvsc.com/index.php/laboratories/#1572363652950-55be08f0-6626>

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