Ultra Light Vehicle (ULV) Research Prototype

EPA DOT Fuel Economy Estimates

JP8 Vehicle

Fuel Economy

14.7 PTM [6.86 MPG]

combined fuel economy

Combined Calculation:
20% Harford
40% Munson
40% Churchville B

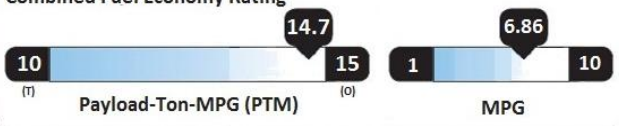
Munson Gravel Terrain	Harford Paved Terrain
17.0 PTM [8.10 MPG]	12.9 PTM [6.14 MPG]
Churchville B Trails Terrain	Tactical Idle at 10kW Export
13.1 PTM [6.26 MPG]	1.27 GPH

These estimates are hybrid vehicle model predictions using the Powertrain System Toolkit (PSAT) at GVW.

30 GAL fuel tank **cost**

$111.90

Combined Fuel Economy Rating



Contract # W91CRB-10-C-0089. Contract was awarded competitively per Federal Acquisition Regulations. Citation of manufacturing or trade name does not constitute an official endorsement or approval of the use thereof.

tardec.army.mil/ulv

MODEL PREDICTIONS and ESTIMATES

Length:	199 inches	**Curb Vehicle Weight:**	13,916 pounds
Width:	95.7 inches	**Payload:**	4,284 pounds
Ride Height:	81 inches	**Gross Vehicle Weight:**	18,200 pounds
Transport Height:	72 inches	**Axle Weight (Front/Rear):**	43%/57%
Wheelbase:	134 inches	**Crew Seating:**	4 + 1 Gunner
Ground Clearance:	5 to 23 inches	**Range (35mph, flat):**	337 miles
Interior Volume:	171 ft3		

U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC)

U.S. ARMY RDECOM TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED. TARDEC

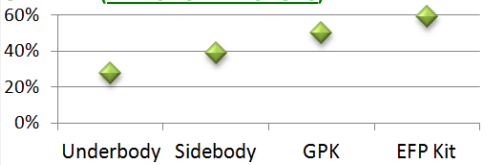
PERFORMANCE @ GVW (MODEL PREDICTIONS)

Top Speed	74 mph
Speed on 5% Grade (Initial/Cont)	45/38 mph
Acceleration 0 – 30 / 0 – 50 mph	5.1/16.2 s
Vertical Step	18 inches
NATO Lane Change	> 45 mph
Lateral Acceleration	0.54 g's
Gradeability Longitudinal/Side Slope	60%/40%
NRMM Cross Country Speed/% No Go	25 mph/18.2%

MRAP FOV-LIKE PROTECTION AGAINST A WIDE RANGE OF POTENTIAL THREATS (BALLISTIC PREDICTIONS)

Underbody Protection
Mines
Improvised Explosive Device
Side Protection
Improvised Explosive Device
Explosively Formed Penetrator
Rocket Propelled Grenade
Small Arms Fire

ULV ARMOR AREAL DENSITY % IMPROVEMENT OVER RHA (BALLISTIC PREDICTIONS)



CONFIGURABLE COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE & ELECTRONIC WARFARE (C4ISR & EW) A-KIT INFRASTRUCTURE DEMONSTRATED TO SUPPORT:

- Mobile Computing Platform RF-7800N-CP for C4I application hosting, network router and switch, video server, data and vetronic interfaces
- AN/VRC-110 Multiband Vehicular Radio System with AN/PRC-152 Type-1 Handheld Multiband Radio
- Dual RF-300M-V150 50 Watt Vehicular Adaptor with two PRC-117G(V)1(C) Type-1 Wideband Multiband Radios with Internal SAASM GPS
- RF-7800I Vehicular Intercom System
- One System Remote Video Terminal and Transceiver with Remote Optical Video Enhanced Receiver
- Fortress Encrypted Tactical Wireless Mesh
- Defense Advance GPS Receiver
- 360° SA Video via 2 FLIR ThermoVision WideEye II's
- Boomerang Geo-rectified Shooter Detection System
- Counter RCIED Modular Countermeasure Suite

SILENT OPERATION @ GVW (MODEL PREDICTIONS)

Battery SOC:	80%-20%	100%-0%
Silent Watch:	4.38 hours	7.3 hours
Electric Range:	12 miles	21 miles

SUB-SYSTEM DESCRIPTIONS

Subaru Boxer Horizontally-Opposed Turbo Diesel
Engine Maximum Power: 175 hp
Rated Engine Torque: 260 lb-ft
JP8, 30 gallon tank

UQM-200 Power Phase Generator and Inverter
Peak Power: 200 kW
Continuous Power: 120 kW
380VDC bus, 6kW 380VDC to 28VDC converters
3kW 380VDC to 12VDC converter

Navitas Li-Iron Phosphate Battery (Li-Fe-PO_4)
Capacity Energy Power: 14.2 kWh
Peak Output Power: 180 kW
Continuous Output Power: 65 kW

American Traction Systems (ATS) Drive Inverters
Remy-410HVH HT drive motors, High Voltage Hairpin Conductor, Permanent Magnet Rotor

EATON E-Locker Differentials Ratio: 3.08:1
LOC Planetary Geared Hubs Ratio: 2.6:1
Gearing ratio overall, motors to tires: 8:1

LiquidSpring Compressible Liquid Adaptive Suspension System: 18 inches of travel, with integrated elastomeric jounce bumper

Hutchinson Wheels: Aluminum, 20" diameter X 11" wide, 40mm positive offset, 335mm bolt circle, 8 hole pattern.

Mickey Thompson Tires: Baja ATZ Radial, 40X14.5R20LT – 4805 lbs load capacity at 65psi

Service Brakes: Outboard mounted, hydraulic, master cylinder push rod, 380mm carbon-ceramic rotors, six piston calipers

Parking Brake: Caliper type – rear wheel outboard, spring activated, hydraulic release

Jankel: Blast Limiting Attenuation Seats

Ultra Light Vehicle (ULV) Research Prototype

U.S. Army
Tank Automotive Research, Development and Engineering Center

The Ultra Light Vehicle (ULV) Research Prototype program enabled the creation of an integrated technology demonstrator vehicle focused on the program's four primary objectives.

Primary Objectives:
1) Protection: Comparable to MRAP FoV
2) Performance: 14,000 lbs CVW
3) Payload: 4,500 lbs
4) Price: $250k at 5k QTY

Predicted Primary Results:
1) Protection: Comparable to MRAP FoV
2) Performance: 13,916 lbs CVW w/ Add-On Armor
3) Payload: 4,284 lbs
4) Price: $260k at 15k QTY

Secondary Objectives:
1) Performance: TARDEC-Selected Tactical Vehicle Mobility Requirements

Predicted Secondary Results:
1) Performance: >90% of the TARDEC-Selected Tactical Vehicle Mobility Requirements

The ULV is an Office of the Secretary of Defense (OSD) funded science and technology effort to explore the art of the possible in survivability technology in order to inform and enhance future production programs. This project partnered with nontraditional defense contractors to access commercial markets, developing solutions and novel approaches that push the limits of a lightweight, low cost, highly survivable vehicle. The high risk/high reward and fast paced (16 months) contract included a mix of innovative, advanced technologies and COTS-based products. The ULV is neither ready nor intended for actual production, and validation testing for performance and survivability will continue into 2014.

The final design includes a contractor designed steel-base occupant-centric cab with the front and rear steel frames extending directly from the cab creating a monocoque structure without a traditional frame. The majority of the vehicle systems attach directly to the front and rear frames. The cab includes lightweight composite armors and various blast attenuating and occupant safety technologies with multi-egress options. The suspension is compressible liquid with a full 18 inches of travel, using long/short arm design offering mobility over rough terrain. The hybrid drive system eliminates the need for under-cab drive components, thus allowing the underbody geometry to present clean load shedding surfaces in a blast event. Drive redundancy consists of two electric drive motors, one front and one rear (only one of which is required for motion), each directly coupled to a differential, and driving planetary geared hubs with a single speed. The planetary geared hubs keep weight to a minimum by reducing the half-shaft torque requirement, keeping each traction motor centrally located between each wheel set, and providing high drive efficiency. The engine/generator "gen-set" mounted in the front provides the continuous power, while the battery mounted in the rear provides power surge and energy storage capability. The combination offers power redundancy, as only one energy source is required for motion, and the battery is capable of moving the vehicle on electric power alone (capable of 10+ mile range on battery alone).

Within the schedule, it was not possible to include all Government Furnished Equipment (GFE) specified in the secondary research objectives. Careful scrutiny of the full menu of GFE led to decisions to eliminate older electronic equipment in favor of a lower weight system with full Internet Protocol control options, improved integration, and focus on warfighter future needs (with warfighter input through Integrated Product Teams (IPT) as well as organized group evaluations). The ULV electronics package chosen for integration represents the full electronic suite capability that is present in similar fielded tactical vehicle fleets focused on using the newest electronic equipment. The use of a common integrated user interface for radio, shot detection, video, and GPS positioning resulted in a significant space and weight savings.

Finally, the nature of the organization and communication plan aided significantly in achieving the rapid design and build completion of the prototype vehicles. Specifically, the IPT structure established by the TARDEC ULV Research Prototype Team was populated by potential stakeholders in the various vehicle technical, performance, and programmatic categories.

LEAD ▪ INNOVATE ▪ INTEGRATE ▪ DELIVER

GROUND SYSTEM SURVIVABILITY (GSS)

ULV Research Prototype Effort Executed By:

TARDEC
HARDWIRE ARMOR SYSTEMS

Additional Key Participants:

DRS TECHNOLOGIES
ROUSH
BOEING
LIQUIDSPRING
NAVITAS SYSTEMS
HARRIS
Dyneema® With you when it matters
AMPS Alternative Motive Power Systems
GKN
HUTCHINSON WORLDWIDE
ARMORLINE
SCHOTT
Remy
American Traction Systems
LOC
PennState

UNCLASSIFIED: Distribution Statement A. Approved for public release. OPSEC# 23835