



U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND

Platform Electrification and Mobility (PEM) Inverter, Electric
Sprocket Drive, and Generator Overview

Joshua Tylanda

Project Lead

CCDC GVSC

**DISTRIBUTION A. Approved for public release;
distribution unlimited. OPSEC #: 6802**



PEM INVERTER REQUIREMENTS

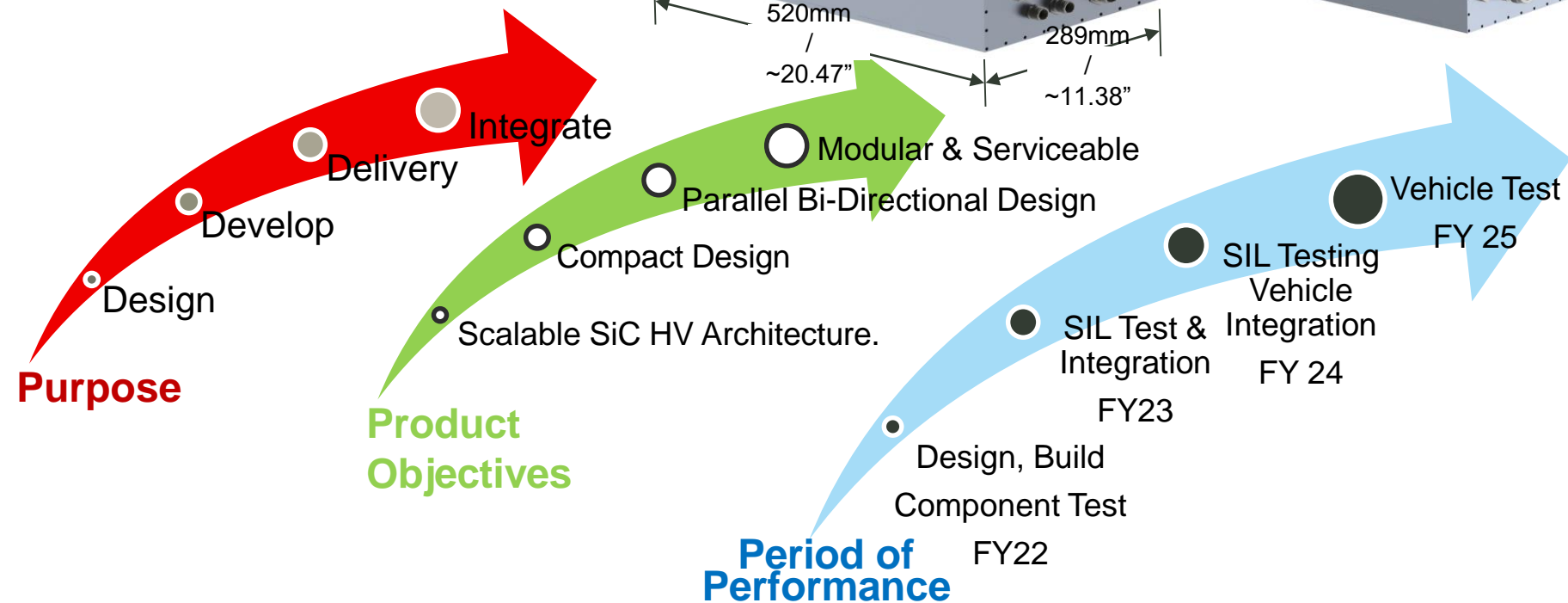
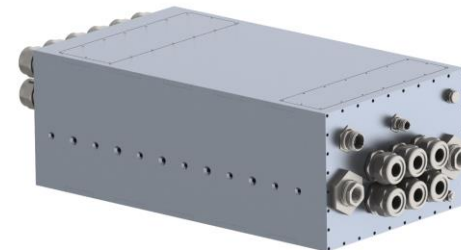
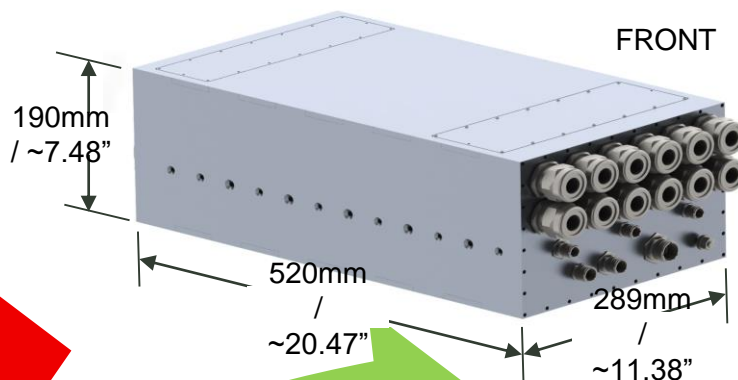


Inverter Requirements at-a-glance:

- Universal bi-directional Silicon Carbide AC/DC inverter for motor drive and regen/generator modes (speed, torque and voltage control)
- 500kW continuous and 640kW transient at 600 VDC at 105C 50/50 EGW coolant
- Three 600 VDC power distribution lanes (2x 1070A & 1x 420A)
- High voltage DC (HVIL) and AC (ACPIL) interlock compatible
- Capable of parallelization modes with synchronization connections
- Ambient environment -46 to 121C
- Electronics rated to 150C
- Complies with environmental including shock, vibration, EMI and lightning



PEM INVERTER OVERVIEW



- Inverter is designed to work with Generator and Electric Sprocket Drive motors on 30T and 50-60T series hybrid tracked vehicle designs.



PEM ELECTRIC SPROCKET DRIVE REQUIREMENTS



Electric Sprocket Drive (ESD) Requirements at-a-glance:

- Modular and/or scalable approach for 30 ton and 50-60 ton solutions
- Pairing with target PEM inverter at AC power interface
- Space claims encompassing motors, brakes, final drives and supporting cooling and actuation systems
- Soft-parallelism of inverters for DC power transfer between left and right side vehicle motors to meet platform mobility needs
- Motor design applicable to multiple platforms. Final drive interface designed to match hull integration for demonstrator (M88)
- AC (ACPIIL) interlock compatible
- 60T motor design pairs with 2 PEM Inverters, 30T design pairs with 1 PEM Inverter
- Ambient environment -46 to 121C
- Complies with environmental including shock, vibration, EMI and lightning

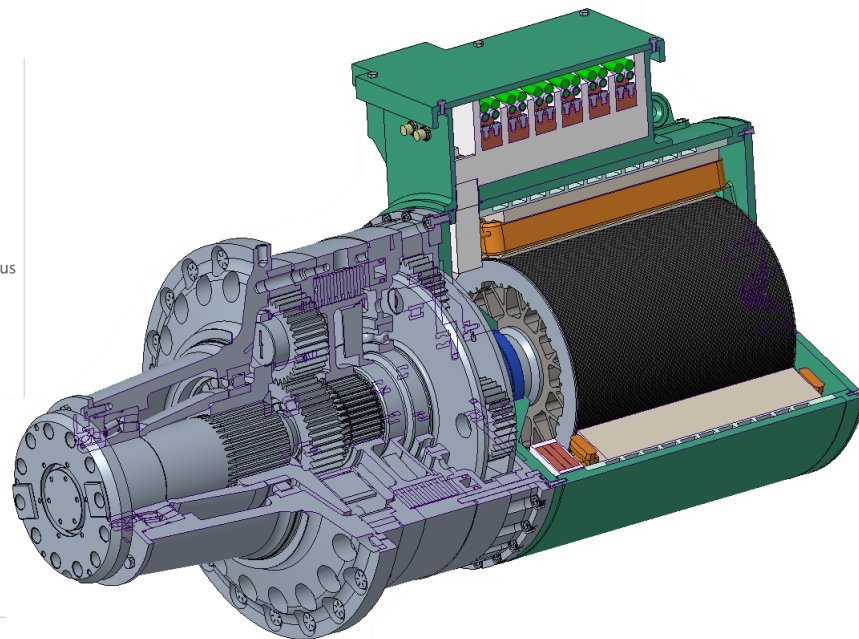
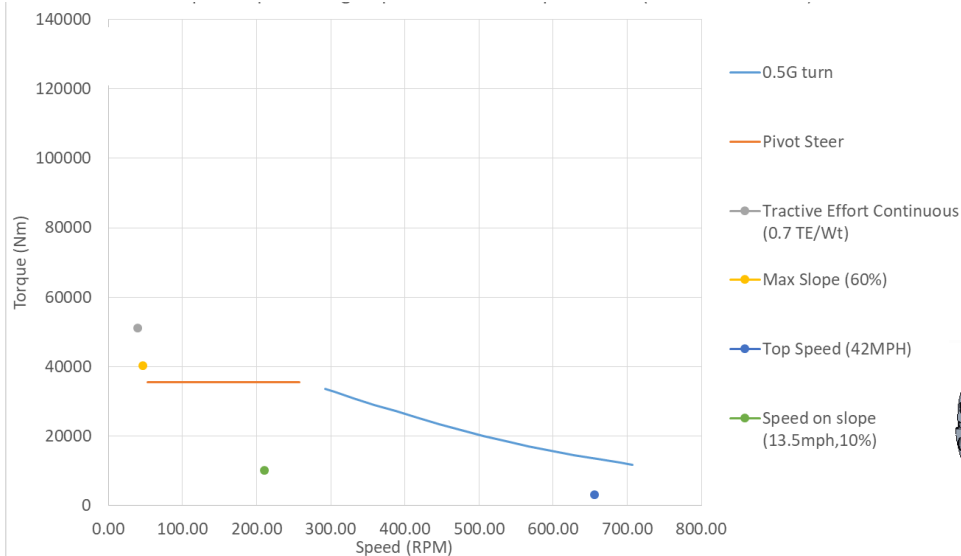
60T vehicle ESD requirements at sprocket



PEM ELECTRIC SPROCKET DRIVE OVERVIEW



50-60T vehicle ESD requirements at sprocket



- Torque/power requirements driven by mobility needs
- Single electrical connection to 30 Ton inverter, dual electrical connection to 50-60 Ton inverters
- Mechanical output to left and right sprocket drives accounting for peak forces (panic breaking/de-track/vertical bump)
- ESD System electrically converts power generation source to torque at the track to maintain the track series hybrid vehicle mobility needs



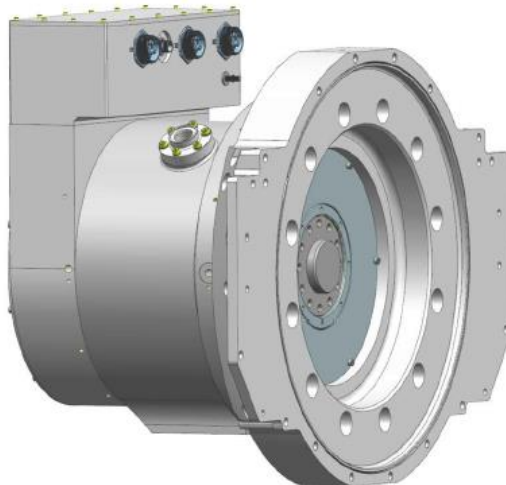
PEM GENERATOR OVERVIEW



50-60T Generator



30T Generator



- Operation in torque (motoring) mode for engine start
- Engine speed control used to achieve 600VDC power output from generator during normal operation
- Direct coupling to Cummins engine for installation within PEM SIL & vehicle
- 2 PEM Inverters pair with 50-60T Generator with parallel windings (752kW electrical output power)
- 1 PEM Inverter pairs with 30T Generator (376kW electrical output power)
- AC (ACPIL) interlock compatible
- Cooling, 105C inlet temp with 50/50 EGW
- Ambient environment -46 to 121C
- Comply with environmental including shock, vibration, EMI and lightning.



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

Segmented Composite Rubber Track (S-CRT) Overview

Craig Schmehl

Technical Specialist

Ground Vehicle Power & Mobility (GVPM)

DISTRIBUTION A. Approved for public release; distribution unlimited.
OPSEC #: 6802

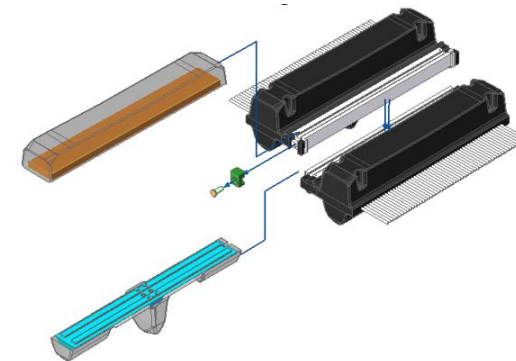
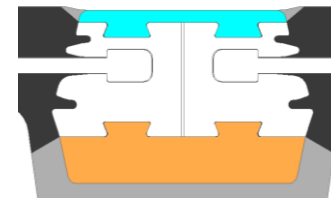
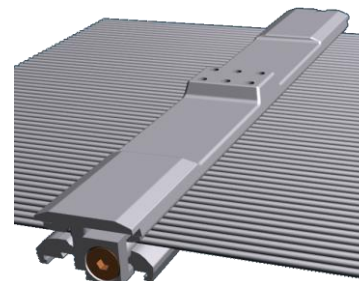


SEGMENTED COMPOSITE RUBBER TRACK (S-CRT)



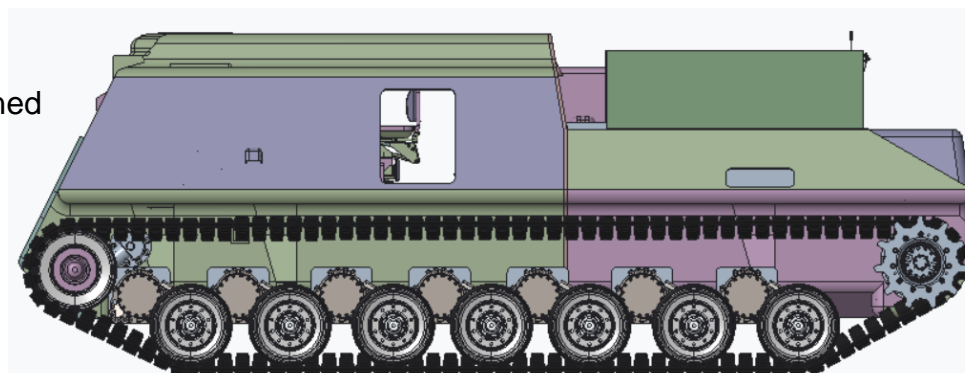
Program Goals:

- Develop a 60 ton / 7 road wheel station capable track that incorporates a joint
 - Increase max vehicle weight capability
 - Ease vehicle installation and reduced special tools
 - Reduce logistical challenges
 - Maintain track weight reduction typically seen with composite rubber tracks
 - Demonstrate true silent mobility with reduced track noise and vibration while operating in electric only mode
- Physically demonstrate and test track system on Platform Electrification and Mobility (PEM) Demonstrator



Program Deliverables:

- CAD models and drawings for integration
- Final Report documenting design process and lessons learned throughout testing and demonstrations
- Manufacture prototype track kit delivered for demonstration
- Collect test data on PEM Demonstrator



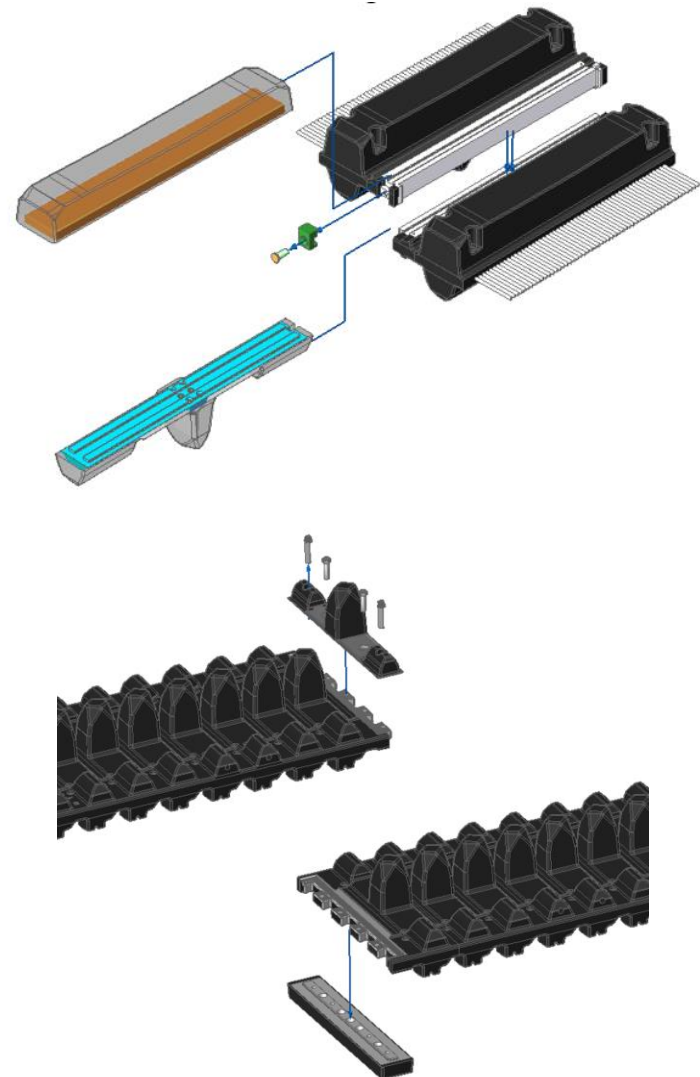


S-CRT SUMMARIZED SPECS



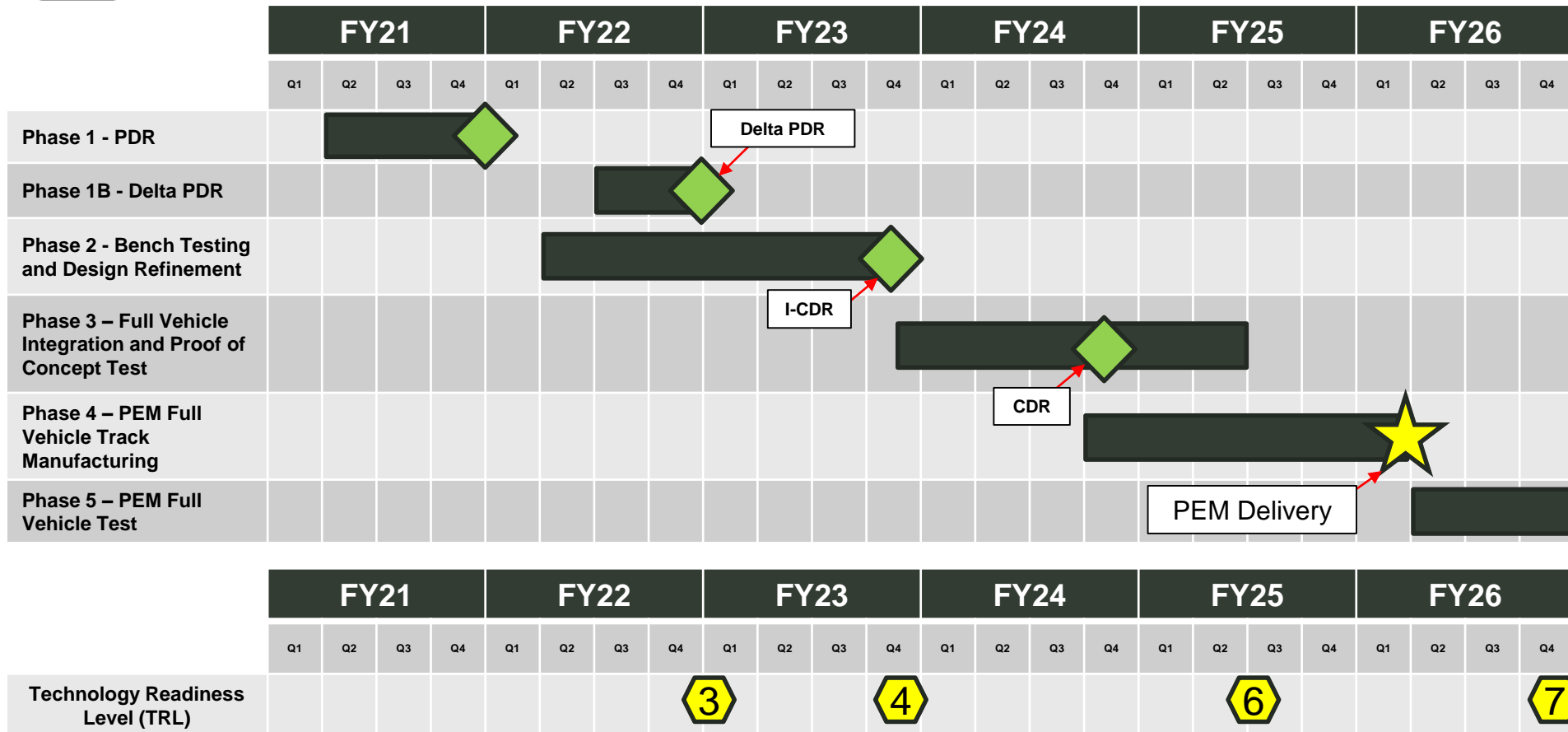
• S-CRT P-Spec

- Segmented Composite Rubber Track
 - Durability: **1,000 miles (T), 3,000 miles (O) at 60 tons/ 7 road wheel stations per side**
 - Track width: **≤ 25 inches**
 - Linear track weight: 87 lbs./ft (T), 68 lbs./ft (O)
 - **Contractor to determine segment length based on durability**
- Road Wheel
 - Durability: 1,000 miles (T), 3,000 miles (O) at 60 tons/ 7 road wheel stations per side with no more than 20% failure
 - Individual wheel weight: 60 lbs. (T), 45 lbs. (O)
 - Diameter: = 25 inches
- Tensioner
 - Durability: 3,000 miles (T), 5,000 miles (O) at 60 tons
- Sprocket
 - Durability: 3,000 miles (T=O)
- Sprocket Carrier
 - Durability: 3,000 miles (T=O)
- Idler Wheel
 - Durability: 1,000 miles (T), 3,000 miles (O)
 - Diameter: = 25 inches





S-CRT SCHEDULE



Key Dates:

- Delta Preliminary Design Review (Delta PDR): November 2022
- Interim Critical Design Review (I-CDR): August 2023
- Critical Design Review (CDR): December 2024
- PEM Prototype Track Delivery: December 2025

Key:



Design Review



Hardware Delivery
– Full Vehicle Set



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

18” External Suspension Unit (ESU) Overview

Craig Schmehl

Technical Specialist

Ground Vehicle Power & Mobility (GVPM)

DISTRIBUTION A. Approved for public release; distribution unlimited.
OPSEC #: 6802



18" EXTERNAL SUSPENSION UNIT (ESU)

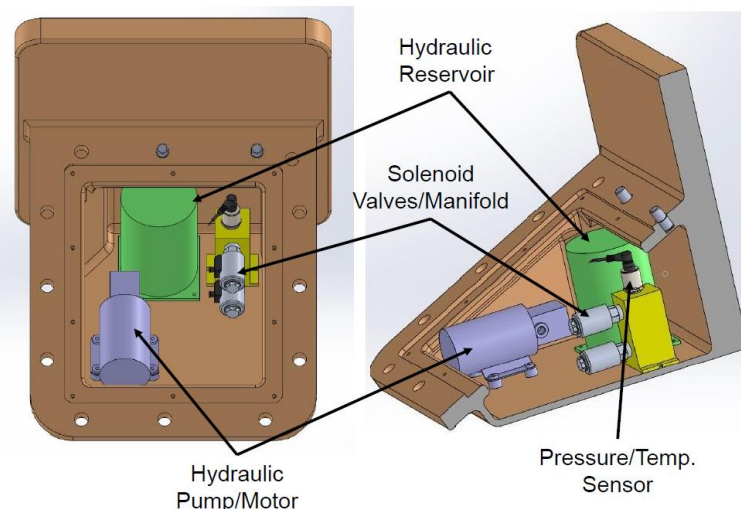
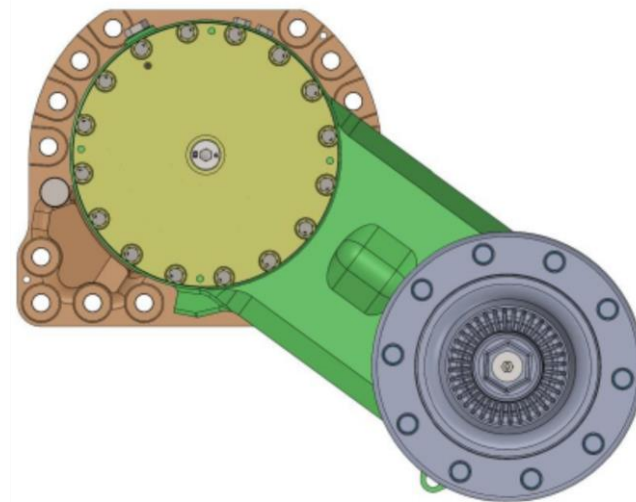


Program Goals:

- Develop a 10,000 lb (T), 12,000 lb (O) capable, 18" external suspension with integrated spring and damping
 - Capable of passive or semi-active damping with minimal modifications
 - Ride Height Control System (RHCS) (+/-6" vertical travel)
 - Track tensioner capable of maintaining track tension with RHCS
- Physically demonstrate and test suspension system on Platform Electrification and Mobility (PEM) Demonstrator

Program Deliverables:

- CAD models and drawings for integration
- Final Report documenting design process and lessons learned throughout testing and demonstrations
- Manufacture prototype 18" ESU's, ride height controller, integrated hydraulic pump, and tensioner delivered for demonstration
- Collect test data on PEM Demonstrator



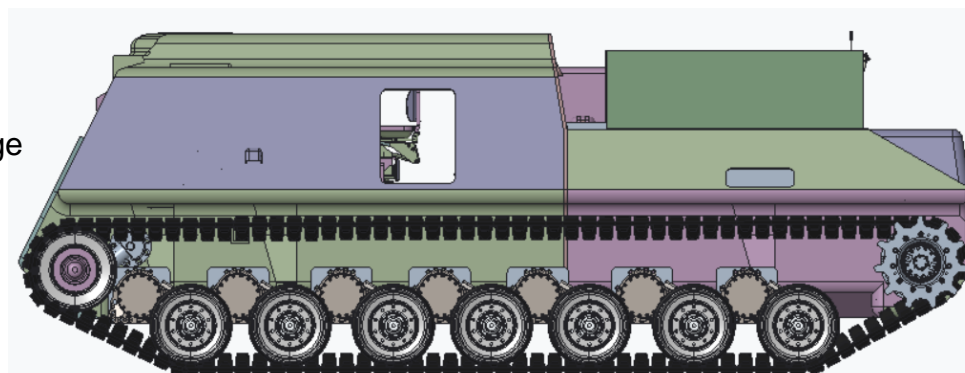
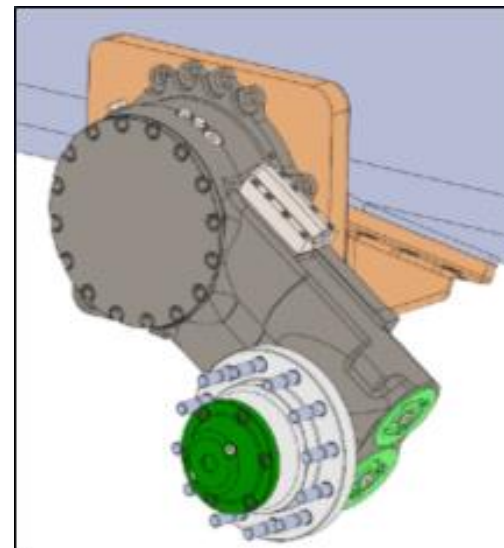


18" EXTERNAL SUSPENSION UNIT (ESU)



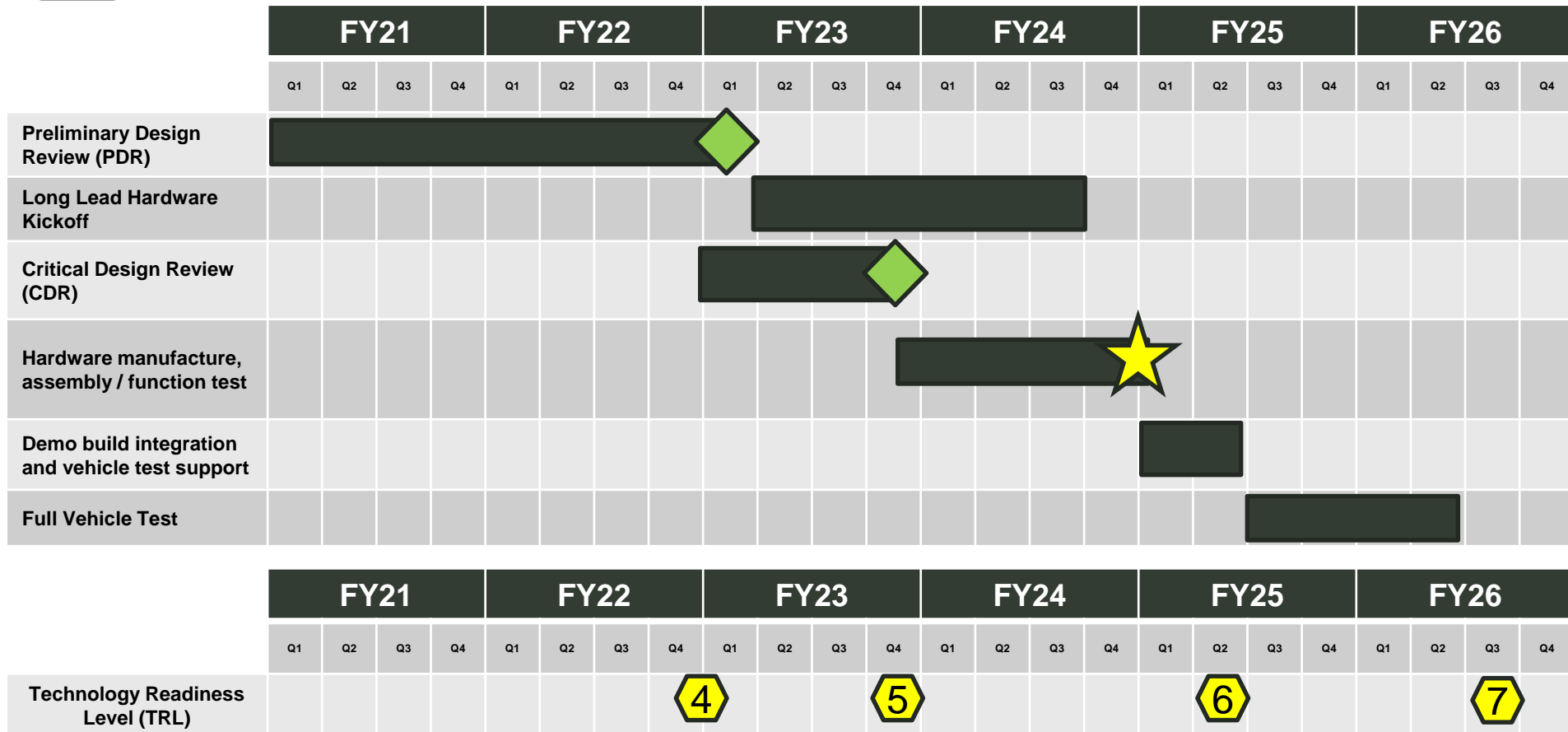
- **System Specs:**

- Total Wheel Travel: **17 in. (T)**, 19 in. (O)
- Rebound Travel: **5 in. (T)**, 6 in. (O)
- Jounce Travel: **12 in. (T)**, 13 in. (O)
- Road Arm Length (Pivot Length): **18 in.** (T=O)
- Spindle Load: 12,000 lbs. max, **10,000 lbs min.** (T=O)
- Wheel Hub Interface: M1A2 Wheel Hub
- MMBF: 5,000 miles (T), 6,000 miles (O)
- Weight: 400 lbs (T), 300 lbs (O)
- Semi-active Damping
- Vehicle chassis attitude control (PEM): 6 in. squat, 4 in. (T) 5 in. (O) increase
 - Gun firing angles
 - Increasing obstacle climb capability
 - Reduce vehicle height for transportation
 - Ease road wheel replacement
- Track Tensioner to accommodate ride height change





ESU SCHEDULE



Key Dates:

- Preliminary Design Review (PDR): December 2022
- Critical Design Review (CDR): October 2023
- PEM Prototype ESU Delivery: October 2024

Key:



Design Review



Hardware Delivery
– Full Vehicle Set



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

Modular High Voltage Concept

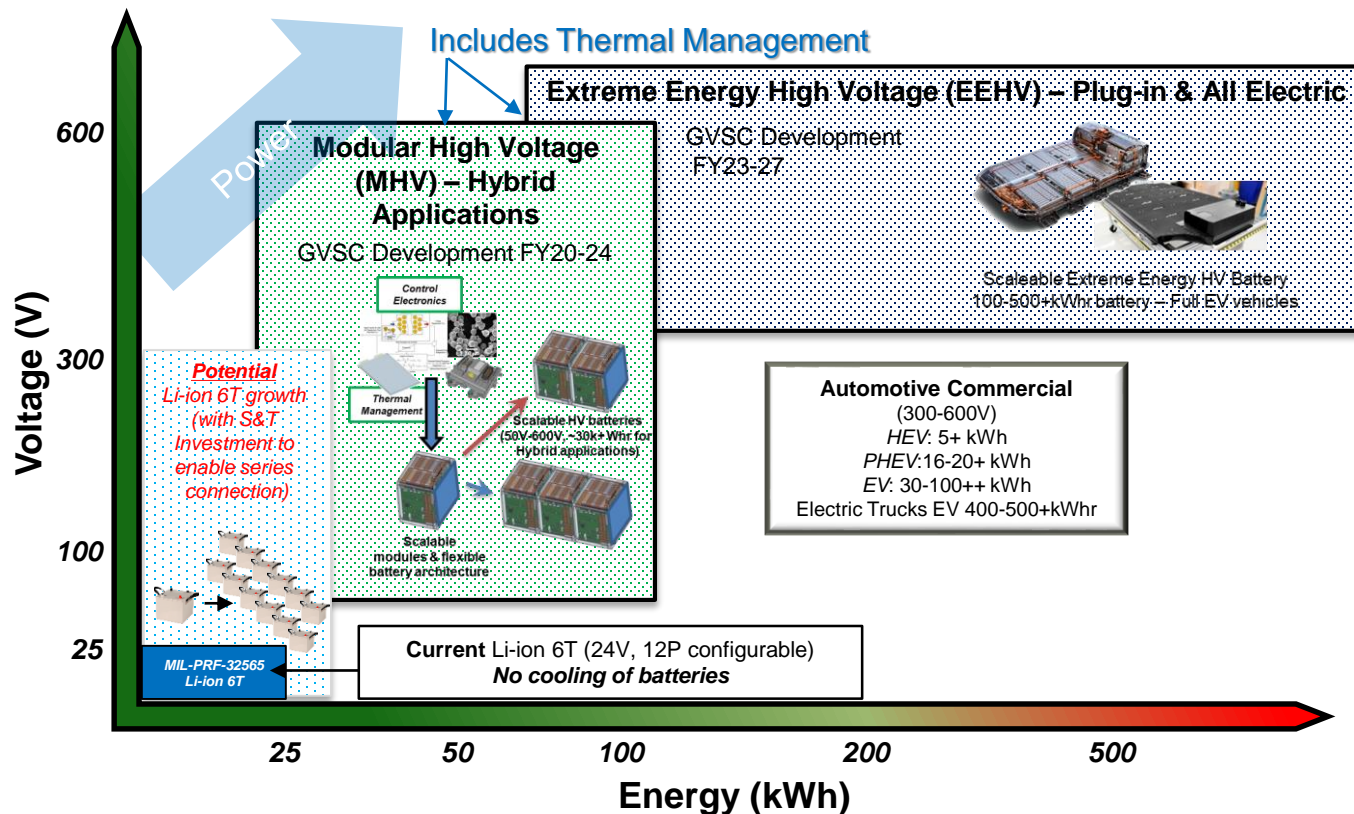
David Skalny
Technical Specialist for Energy
Storage
DEVCOM GVSC



GVSC Energy Storage Roadmap

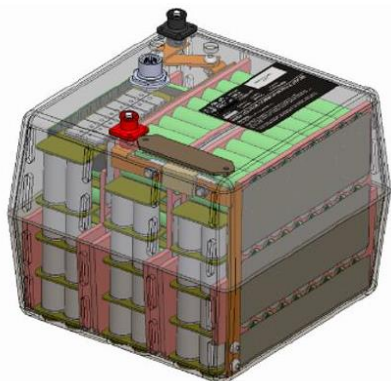


To meet unique military requirements including Navy Safety certification, standardized/scalable military batteries are needed

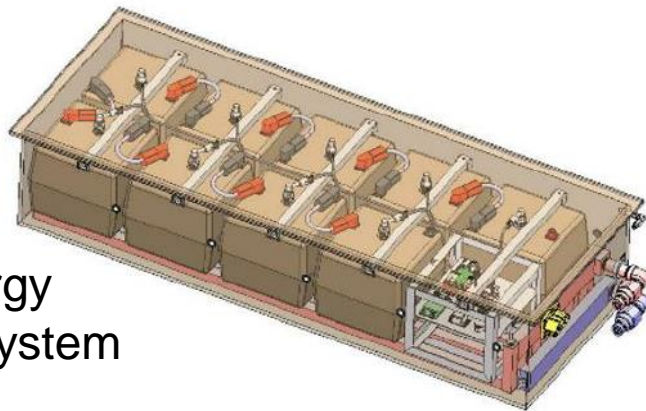




Modular High Voltage (MHV) Overview



High-Voltage
Common
Module
(HVCM)



MHV Energy
Storage System
(MHVESS
Pack)

Key Features: *Flexible architecture to accelerate vehicle hybridization*

- Voltage: 50 – 600+V
- Energy: 3 – 100 kWh
- Scalable modules (~50V) connected in series/parallel for various applications.
- Qualification to occur at the module level.
- Some consideration for backward compatibility of current force vehicles
- Full operational capabilities between -30°C to 60°C WITH thermal management. Reduced operation down to -46°C or up to 71°C or WITHOUT thermal management.
- Module BMS: provides status and monitoring information for safe operation of pack, built-in tests, diagnostics and cell balancing.
- *Pack BMS (NextBMU Mini)*. Reports pack status and monitoring info to vehicle digital com buses. Controls of battery thermal management, battery protection and pre-charge/main contactors.



THANK YOU



For more info:
Laurence Toomey, Ph.D.
Branch Chief
Energy Storage Team

laurence.m.toomey2.civ@mail.mil
Office: 586-282-4756
Cell: 586-219-4320