Power-Managed HMMWV Demonstrator

Joint Service Power Expo
April 25, 2007

Problem statement

- There is an urgent theater requirement for a self protection and IED defeat suite of subsystems on tactical wheeled vehicles (TWVs)
- HMMWV and EOD armored trucks (i.e. Buffalo, Cougar, RG31, etc.) do not have enough electrical power for this equipment
- The immediate power requirement is for 28VDC… 400 amps across the entire engine operating range
  - ONR/USMC OBVP program is developing AC export power
  - 115/230VAC is a *future* requirement for IED defeat
- DoD is seeking alternatives

Urgent Warfighter need

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HMMWV integration considerations

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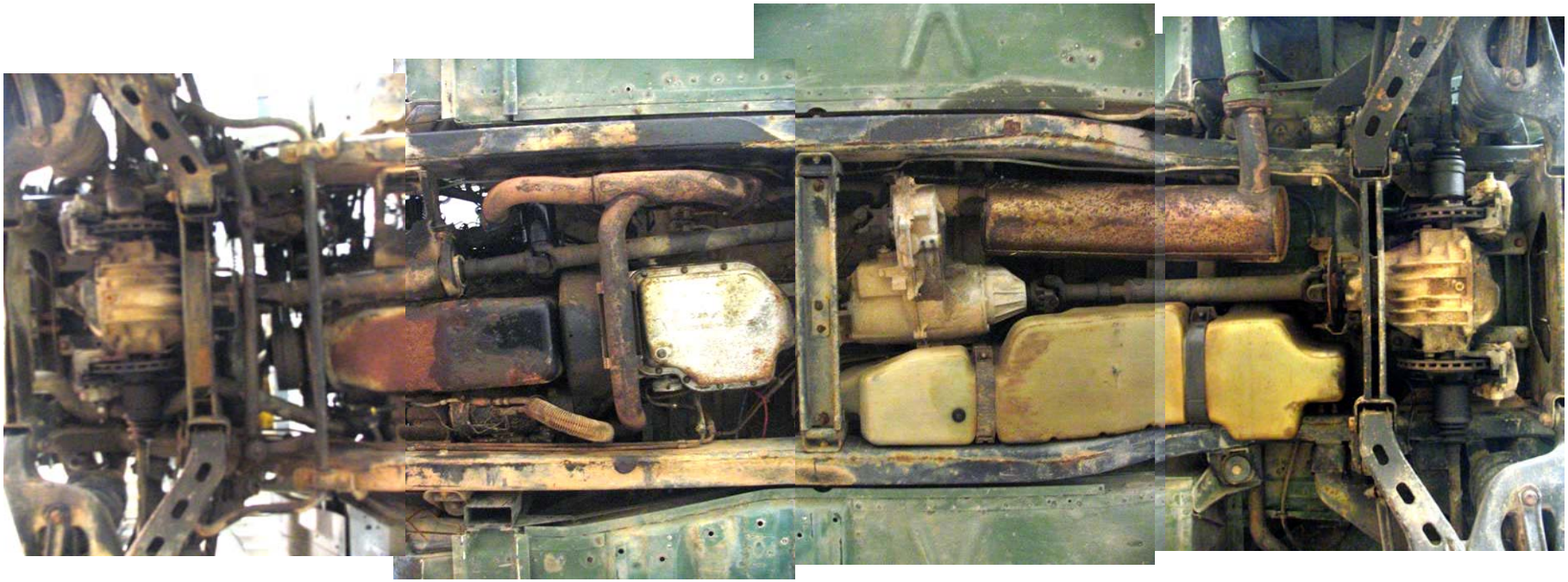
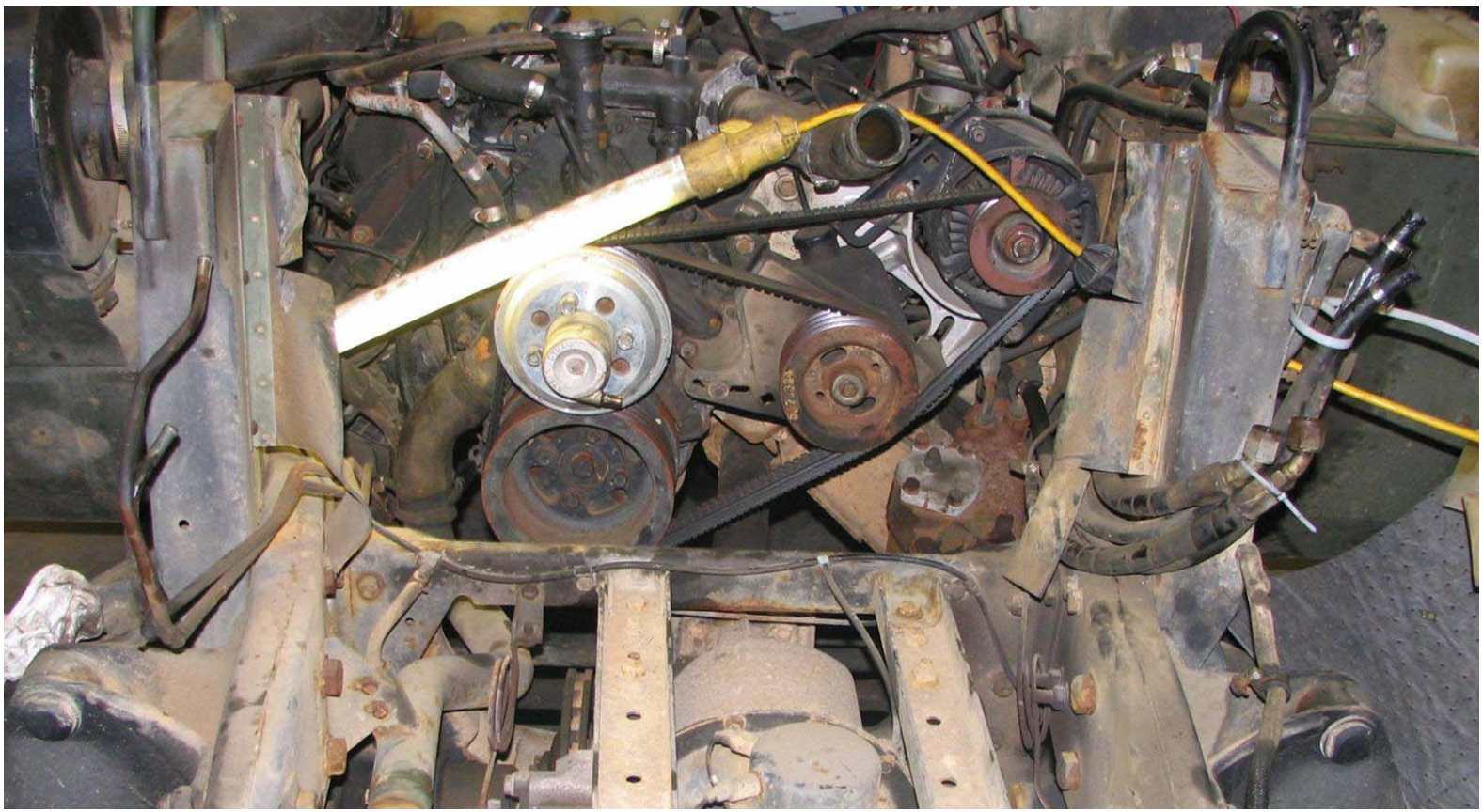
HMMWV chassis packaging



No space claim available under the chassis

HMMWV engine with v-belts (old 6.2L)



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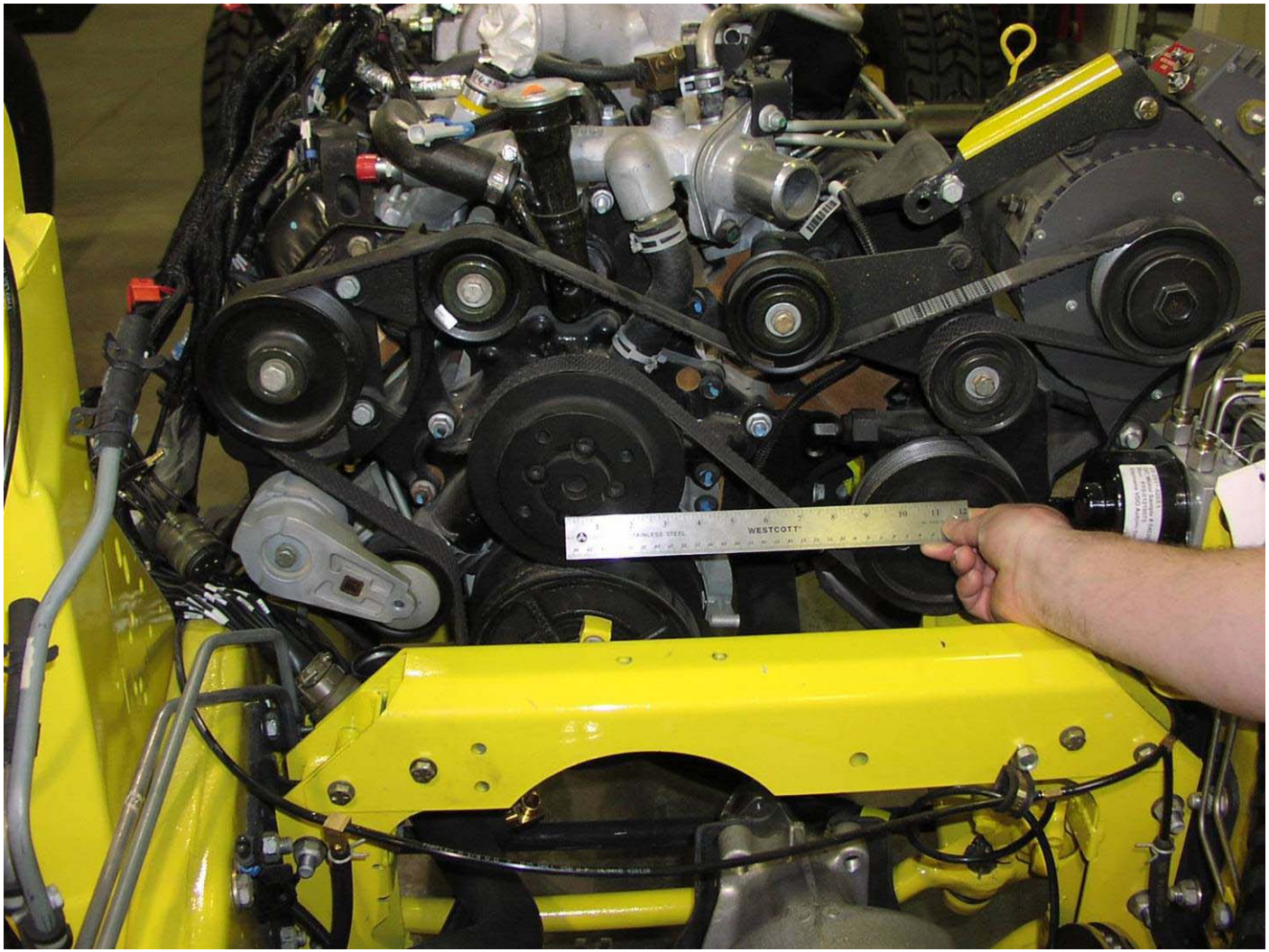
HMMWV engine with serpentine belt (new 6.5L)



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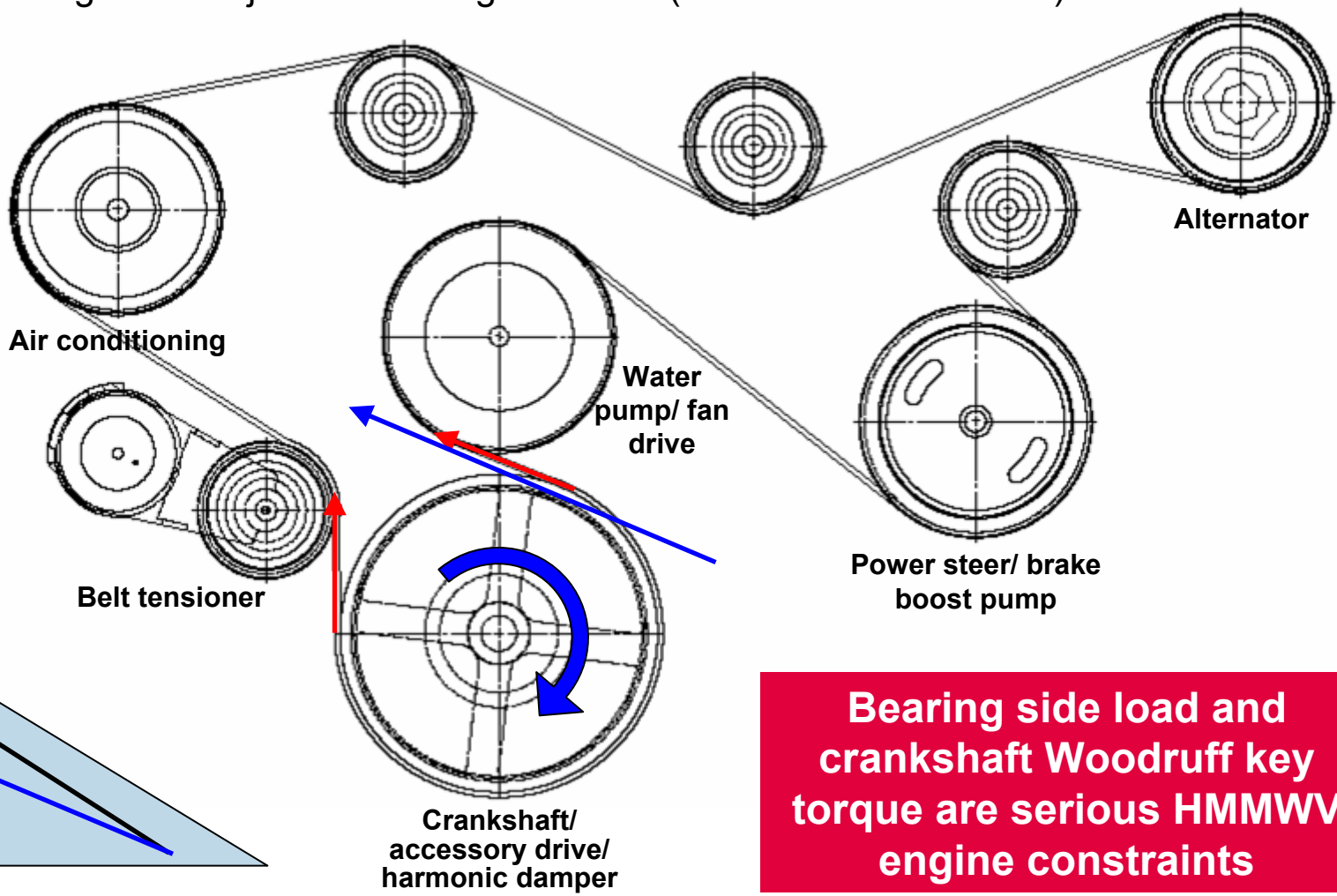
A) Static belt tension force vector

B) Pulley torque force vector (acts on crankshaft key)

C) Pulley torque reaction force (due to sum of all mechanical loads)

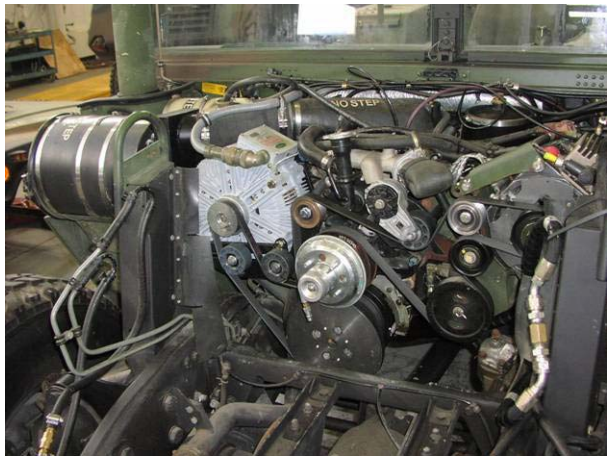
Engine main journal bearing side load (vector sum of A and C)



Bearing side load and crankshaft Woodruff key torque are serious HMMWV engine constraints

Potential solutions

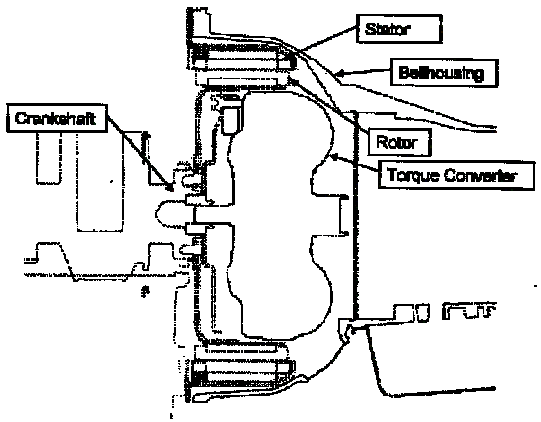
Dual belt driven HV generator



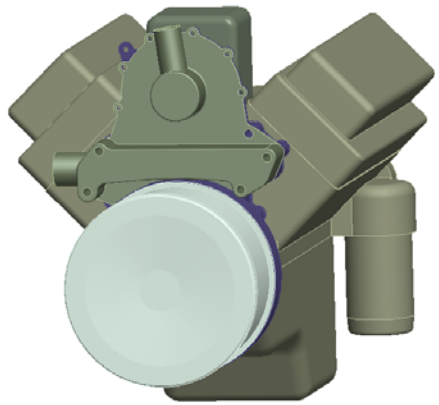
Alternator + belt driven HV generator

Turbo alternator

Conventional 28VDC alternators



Flywheel ISG



Front crank mount ISG

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Solution comparison

- Single and dual belt driven high voltage generators
  - + COTS solution, easy to install, low cost
  - − Won't make full 400 amps 28VDC at idle, belt drive issues
- Turbo alternator
  - + Small, lightweight, easy to install
  - − Will not make power at idle, high risk approach
- Conventional 28VDC alternators
  - + Easy to install, low cost, mature technology
  - − Won't make full 400 amps 28VDC at idle, belt drive issues, inefficient
- Flywheel integrated starter generator (ISG)
  - + Ideal solution for new vehicle designs
  - − Retrofit intrusive, requires transmission and torque converter removal / mod
- Front crank mount ISG
  - + Will make 400 amps 28VDC at idle, field retrofittable, efficient, robust
  - − Retrofit more complex than belt drive approaches

Front crank mount integrated starter generator (ISG) w/ electric accessories Power-managed HMMWV

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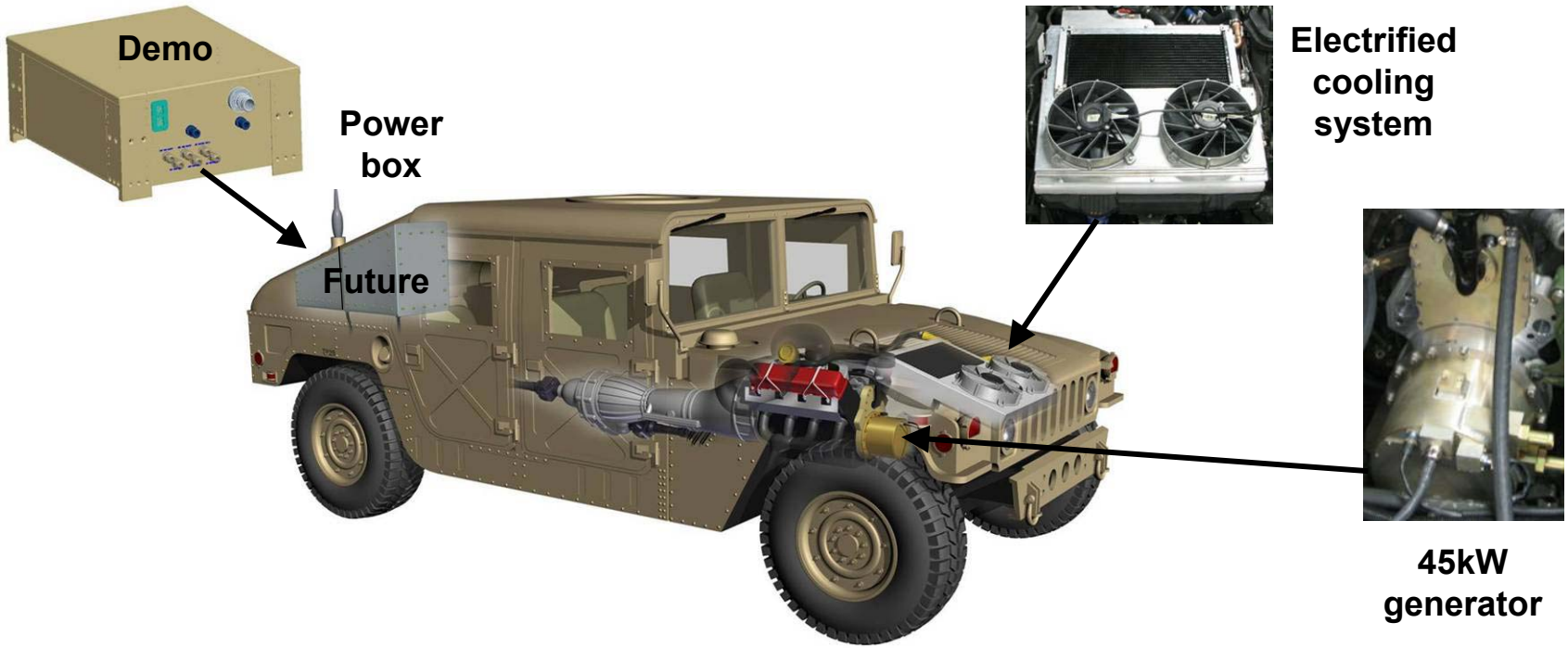
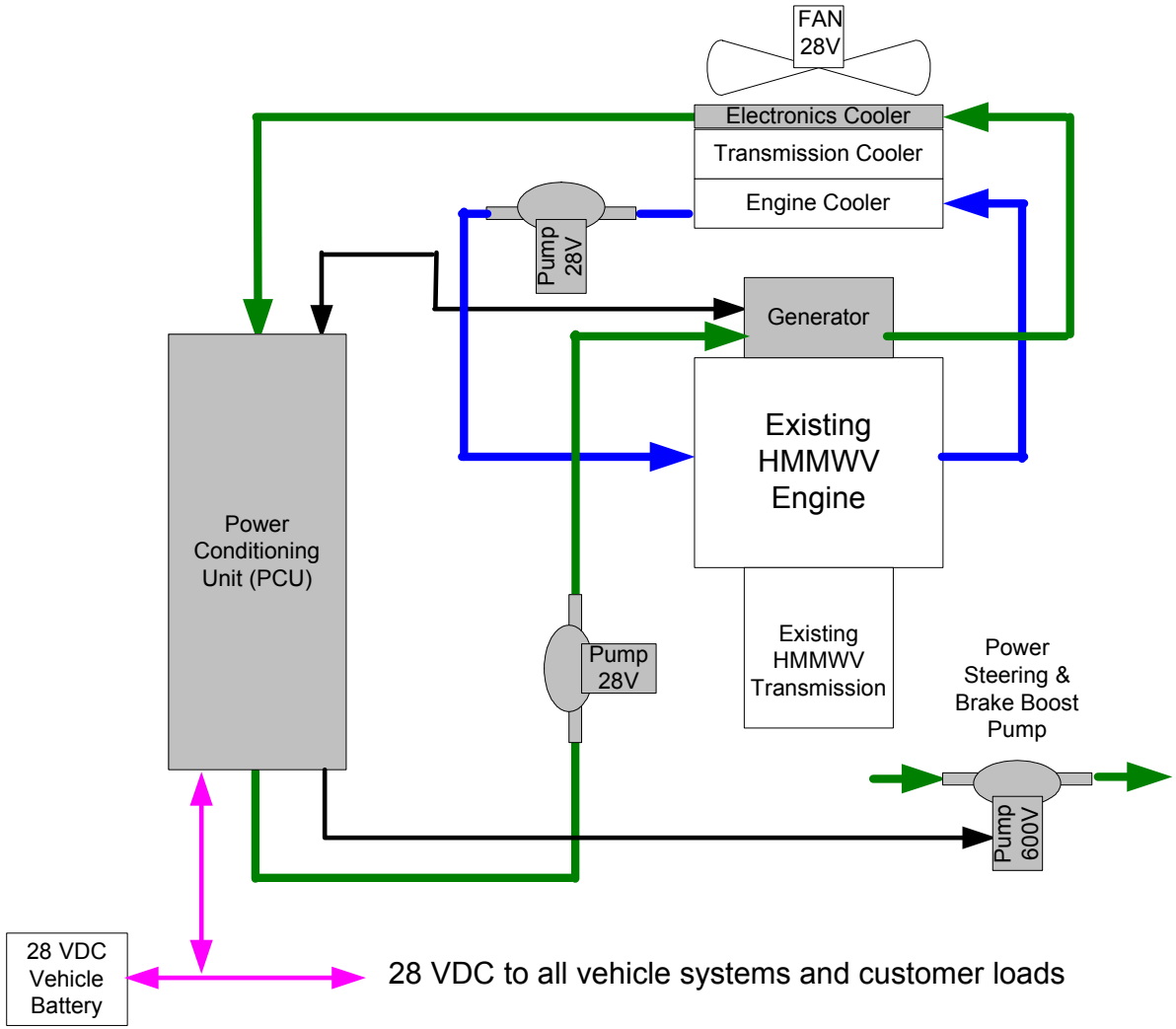
Power-managed HMMWV overview



- Provides 400 amps of 28VDC power (11.2kW) over the entire engine operating range
- Provides 1kW 115VAC power (expandable to 30kW 230VAC power)
- Generator installs directly on engine crankshaft for high reliability and high power capability
- Automotive accessories are electrified for high efficiency and superior health monitoring
- Cooling system is electrified for superior engine cooling performance, even at low speeds

System architecture



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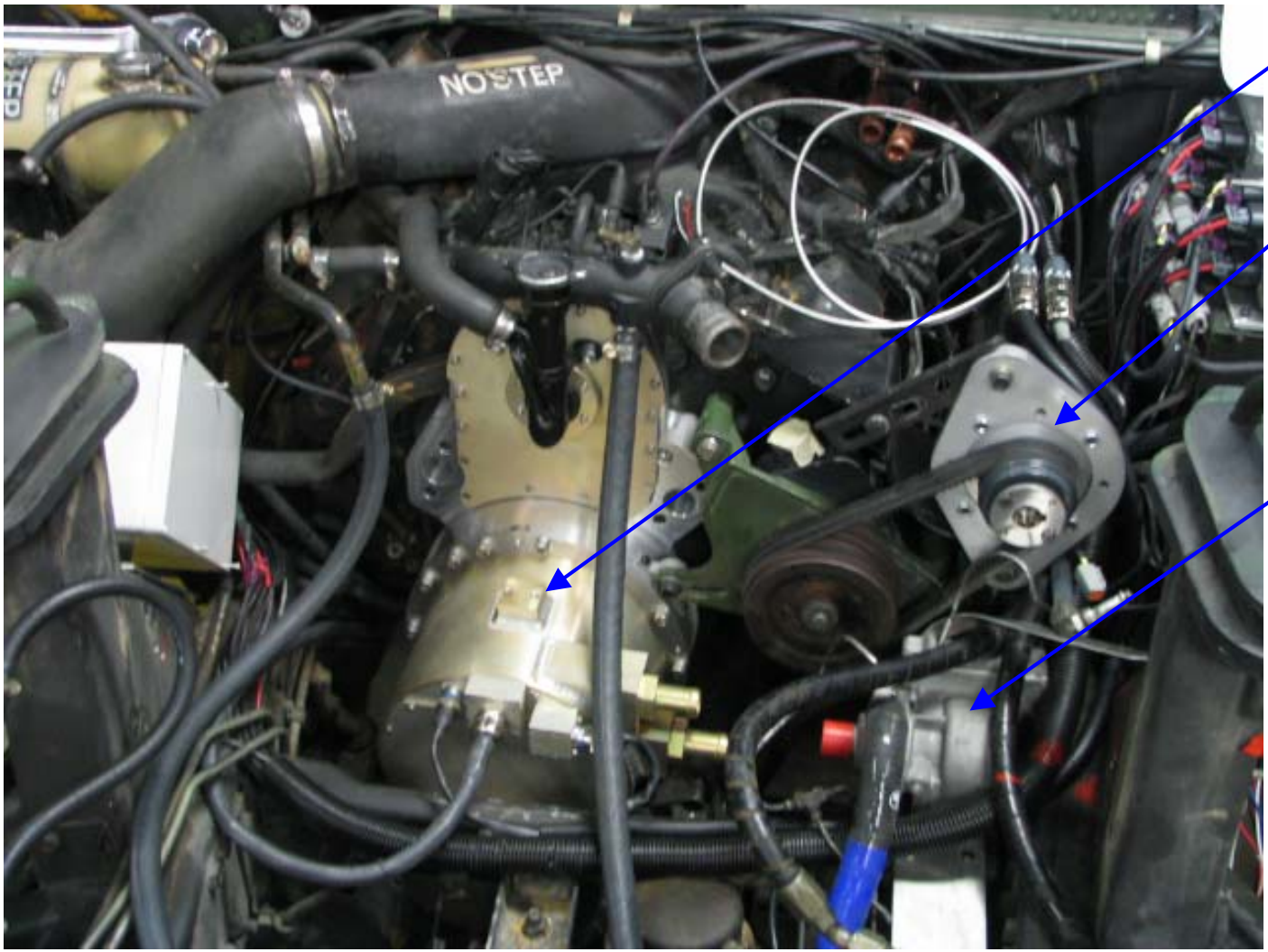
Engine dress



ISG mounted on HMMWV engine crankshaft

Electric motor powering existing power steer pump

Generator and electronics cooling pump

HMMWV cooler stack removed for clarity

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Cooler stack and electric accessories installation

Engine fan controllers (4)

Electronics and generator Cooler

Main cooling fans (two of 4)

Engine radiators

Engine water pump and controller

All engine accessories are power-managed

Demonstrator status

- Vehicle build complete
- 400 Amp power delivery and electric accessory functions verified
- Final integration and road testing in process
- Will be available for targeted customer demonstrations in May 2007

Summary

- Satisfies urgent theater requirement for vehicle power
- Provides 400 amps of 28VDC over the entire engine operating range
- 30kW of clean 230VAC power may be added (as an option)
- May be installed in the field
- Space claim is compatible with HMMWV
- Will work on transmission PTO (for armored trucks)
- Improves HMMWV fuel consumption and system reliability
- Enhances HMMWV cooling system performance
- Flexible common modular power system (CMPS) architecture leverages FCS and ground combat vehicle developments