U.S. Army
Research, Development & Engineering Command

On-Board Vehicle Power Briefing & Way Forward

25 April 2007

Power & Energy
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Outline & Purpose

Purpose

Summarize results of collaborative RDECOM Power & Energy IPT assessment, recommendations, and way forward for meeting On-board Vehicle Power Needs Statement

Background

- **On Board Vehicle Power JUONS, 17 Jul 06**
- JRAC agreement to support, O/A 7 Sep 06
- P&E IPT initial assessment, 12 Sep 06
- Briefing to JIEDDO, 5 Oct 06 (updated 6 Oct 06)
- CERDEC Power Assessment, Sep – Oct 06
- COS IPT Face-to-Face, 18 Oct 06
- MG Nadeau and COL (P) Dellarocco briefing, 19 Oct 06
- JRAB Pre-Brief, 9 Nov 06
- AR2B (Army Resources and Requirements Board) – validates reqms
- **JRAC Briefing/Decision, 16 Nov 06**

Bottom Line Up Front

- IPT conducted detailed technical analysis and power assessment versus JUONS nominal requirements
- JIEDDO PIR defeat systems represent major contributor to power requirements
- On-going and future vehicle power programs do not address urgent/immediate need for legacy fleet
- **Recommended Approach**:

HMMWV (M1114)

- **Technical Approach:**
  - 400A Niehoff MIL-STD alternator using enhanced pulley
  - Include 150-400W DC/AC inverter with convenience outlets
  - If increased power required above 60A (e.g., to meet CREWS future spirals) add Automatic Throttle Control in production kits
- **Cost:** $0.86M for initial integration, testing/safety qualification, fielding and operational user assessment of 15 integration kits
- **Schedule:**
  - 120 days from approval to delivery of kits in theater
  - 165 days to operational assessment; procurement approval
  - TBD days to first production kit deliveries

RG-31

- **Technical Approach:**

  Consider two approaches - evaluate on risk and component availability.
  - **ALT 1: Immediate Requirement:** 280A Niehoff alternator (MIL-STD, on Stryker) using enhanced pulley and high idle; include 150-400W DC/AC inverter convenience outlets
  - **ALT 2: Potential Spiral Improvement:** 400A Alternator (e.g. Fisher A5/60, Niehoff, other), coupled to AC/DC converter; include 150-400W DC/AC inverter convenience outlets
- **Cost:**
  - **ALT 1:** $0.55M for initial integration, testing/safety qualification, fielding and operational user assessment of 5 integration kits
  - **ALT 2:** $1.08M for initial integration, testing/safety qualification, fielding and operational user assessment of 5 integration kits
- **Schedule (ALT 1 only)**
  - 120 days from approval to delivery of kits in theater
  - 165 days to operational assessment; procurement approval
  - TBD days to first production kit deliveries

- REF and CERDEC conducting real world power assessment in theater – 60 day effort

Need Statement

System Definition and Power Requirements

- **Operate Following Systems**
  - Communications Equipment - SINCGARS
  - Blue Force Tracker (BFT)
  - IED Defeat Equipment
    - Rhino
    - Blowtorch
    - Electra
    - Dragon Spike
  - Common Remote Operating Weapon System (CROWS)
  - Counter Radio-control- IED Electronic Warfare system (CREW)

- **Installation on Following Vehicles**
  - M11XX HMMWVs
  - RG-31
  - Buffalo
  - Cougar

- **DC Power**
  - 28 VDC (14 VDC for engine controls)
  - 250/390 amp (Standard/High Idle)
  - Stationary Power (with vehicle in park) 15-20 kW
  - Alternator must fit in same location as OEM alternator

- **AC Power**
  - 3 phase 115V AC 400 Hz
  - 220V AC split phase 60 Hz
  - 120V AC single phase 60 Hz
  - Require no more than 30 HP to generate 15 kW

- **Power Management**
  - DC Objectives: 40 lbs / 1.5 cu. ft.
  - AC Objectives: 50 lbs / 1.5 cu. ft.

"The On-Board Mobile Power System is a vehicle mounted power generation system designed to support the high amperage requirements of current and future vehicle mounted Counter-Improvised Explosive Device (C-IED), Command & Control (C2) and Force Protection Systems."

Information extracted from need statement dated July 2006.

Note: Power requirements continue to evolve. Additional equipment will be added and/or removed from this system definition.

CERDEC Systems' Power Analysis Data

SYSTEM		Listed in Needs Statement	Voltage (DC)	CURRENT (Amps)		
				Standby	Nominal	Peak
Blowtorch		X	28	0.1	60	190
BFT	(Blue Force Tracker)	X	28	0.5	2.9	20
CREW	Current System	X	28	4.5	0	13
	Upgrade (Due Dec 06)		28	4.5	0	20
CROWS	M151 Protector	X	28	5	7	30
	XM101 CROWS		28	4	18	36
Gyrocam	GyroCam system		28	0	6	15
	Laserdyne Monitor		28	0	2	2
	Microwave		13.5	0	5	5
	Mast (w/ vehicle pneumatic)		28	0	0	2
	Mast (w/o vehicle pneumatic		28	0	0	22
Rhino		X	28	0	40	48
SCIMITAR			28	0	26	73
SINCGARS	VRC-87, 88 (Single Short Range)	X	28	1.0	2.1	4.0
	VRC-89, 91 (Short/Long Range)		28	1.3	8.7	14.0
	VRC-90 (Long Range)		28	1.0	2.0	4.0
	VRC-92 (Dual Long Range)		28	1.4	13.9	18.5
Spirit Hawk	Current Prototype		28	0.7	0.7	2
	Rugged Version (being designed)		28	2.9	2.9	8
TALON	(Battery Charger)		120 VAC	0	2.5	4

Note: Information displayed in this chart was provided by system PM Office, responsible RDEC, or system manufacturer's engineering department.

System owner recommended design load.

Denoted significant JIEDDO system requirements

CERDEC Power Generation Analysis

- **Analysis of operational current requirements shows that the vehicle will require 155 amps (HMMWV) and 173 amps (RG-31).**
- **Amperage (current) requirements significantly lower than stated in the Need Statement – decreased by more than 50%.**
- **Assumes all systems being used at the same time (worst case).**
- **On-board batteries will support short duration (< 1 sec) power spikes (common approach)**
- **TALON robot and Spirit Hawk not included in Need Statement.**
- **SCIMITAR not included per JIEDDO instructions.**
- **AC Power not required for interim solution**
- Inadequate power with existing equipment at curb idle.

System	M1114 (Amps @ 28 VDC)	RG-31 (Amps @ 28 VDC)
Basic Vehicle Load *	35	40
Battery Charging	5	5
SINCGARS **	13.9	13.9
Blue Force Tracker	2.9	2.9
Subtotal	56.8	61.8
CROWS	18	18
CREW	20	20
Rhino ***	N/A	N/A
Blowtorch	60	60
Gyrocam	N/A	13
Subtotal	98	111
TOTAL	154.8	172.8

* - RG-31 not verified at the time of this briefing

** - Load during dual channel long range transmission. During active receiving load drops to 1.4 A

*** - JIEDDO/REF indicate Rhino and Blowtorch not likely co-mounted. Blowtorch is worst case.

Potential HMMWV Solutions

Decision Summary

Potential Solution	Derated Amperage (A)	Excess Current (A)	Technical Risk	Operational Risk	Schedule	First Article Integration, Testing & Field Eval Costs	Fielding Cost (Per Unit)
400 A alternator, high idle setting	275.2	120	Low	Med	120 days	$0.86 M	$ 8 K
✓ 400 A alternator, enhanced pulley	215	60	Low	Low	120 days	$0.86 M	$ 9.5 K
400 A alternator, high idle setting, enhanced pulley	309.6	155	Low	Med	120 days	$ 1 M	$ 9.5 K
Fisher A5/60 Alternator	250	95	Med	Low	120 days	$ 11.7 M	$ 36 K
Fisher A5/60 Alternator, high idle	392	237	Med	Med	120 days	$ 11.7 M	$ 36 K

* Costs are engineering estimates as of 19 Oct.

Potential RG-31 Solutions

Decision Summary

Potential Solution	Derated Amperage (A)	Excess Current (A)	Technical Risk	Operational Risk	Schedule	Development First Article Integration, Testing & Field Eval Costs	Fielding Cost (Per Unit)
280 A alternator, high idle setting, enhanced pulley	176	3.5	Low	Med	120 days	$ 0.550M	$ 9.7 K
Fisher A5/60 Alternator (drop in)	250	77	Med	Low	220	$1.08M	$16 K
Fisher A5/60 Alternator, high idle	392	219	Med	Med	120 days	$ 11.0 M	$ 46 K
280 A Alternator & Fisher A5/60 Alternator Co-mount	465	292	Med	Low	120 days	$ 11.0 M	$ 46 K

* Costs are engineering estimates as of 19 Oct.

Strategies for Meeting CREW Spiral Power Increases

- Potential increases in near- and far-term power requirements due to new CREW spiral developments
- FY07 - <30-80A (Spiral 2.1)
- FY08 - <80-160A (Spiral 3.2)
- Estimates are “swags” – not based on actual technical information at present
- Likely to be much lower

HMMWV (M1114)

- **Current Recommended Technical Approach:**
  - 400A alternator with enhanced pulley
  - provides >60A extra power to current reqms
- **Spiral 2.1 (FY07) Technical Approach (if reqd):**
  - Use 400A alternator with enhanced pulley if final power increase <60A
  - Use 400A alternator with enhanced pulley with Automatic Throttle Control (ATC) if power increase >60A
  - Provides >75A excess power above CREW 2.1 reqm
- **Spiral 3.2 (FY08) Technical Approach (if reqd):**
  - Use 400A alternator with enhanced pulley with Automatic Throttle Control
  - Provides 155A of projected (conservative) spiral power requirement
  - Nearly meets even most pessimistic

RG-31

- **Current Technical Approach:**
  - 280A alternator with enhanced pulley and high idle
  - provides ~4A extra power to current reqms
- **Spiral 2.1 (FY07) Technical Approach (if reqd):**
  - Run parallel development of drop in 400A alternator (Fisher A5/60, Niehoff, or other).
  - Doesn’t meet 120day requirement due to lead time on alternator
  - Provides 77A excess power over current requirements
  - Substantially meets maximum potential requirement of 80A.
  - Cost only marginally higher (<$1M)
- **Spiral 3.2 (FY08) Technical Approach (if reqd):**
  - Use ~400A (Fisher A5/60, Niehoff, other) alternator with high idle setting

  Add high idle to Spiral 2.1 solution

  Provides ~219A extra power requirement over current requirements

SOLUTIONS

HMMWV – simply add ATC later (if reqd)

RG-31 – run parallel effort using different 400A (Fisher, Niehoff, or other)

Recommended HMMWV & RG-31 Solutions

VEHICLE	TECHNICAL APPROACH	SCHEDULE (Delivery to Theater)	FIRST ARTICLE INTEGRATION, TESTING & FIELD EVAL COSTS (15 HMMWV & 5 RG-31)	PRODUCTION / INSTALLATION COSTS Unit / Total (18669 HMMWV & 321 RG-31)	RISK & POTENTIAL ISSUES
HMMWV (M1114)	400A Niehoff Alternator w/ enhanced pulley	120 days	$ 0.860M	$ 9.5 K / $177.8 M	Low risk Availability of production alternator
RG 31	280A Niehoff w/ enhanced pulley and high idle	120 days	$ 0.550M	$ 9.7 K $3.1M	Moderate risk Availability of alternator Design of pulley and throttle control
	400A Alternator (Fisher A5/60, Niehoff, other) (Drop-in replacement)	220 days	$1.08M	$ 16 K $5.1M +	Moderate-High risk Availability of alternator Power Conditioning development

For RG-31, pursue 280A Niehoff solution initially.
Run parallel evaluation of larger (e.g. 400A) alternators in preparation for potential CREW spiral power requirements.

+ - Rough production cost estimate, will change with development

HMMWV On-Board Power Management Plan

15 - M1114 Vehicle Kits

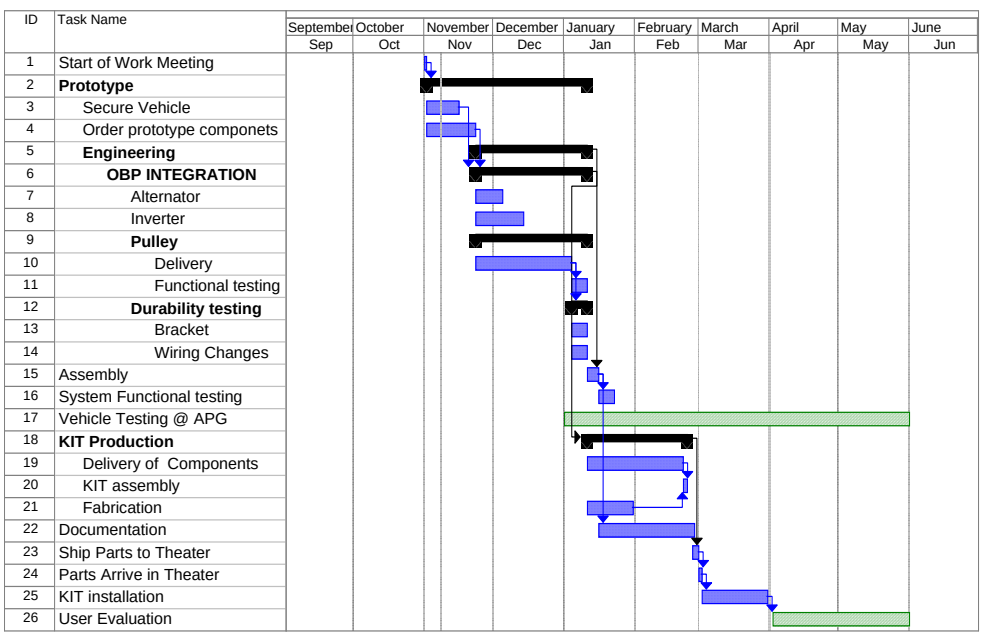
- **Description:**
  - 400 Amp alternator upgrade with advanced pulley
  - AC/DC Inverter
- **Capability Gap**
  - Current 75 Amp at idle, min goal 155 Amp with a target of 200Amp at idle.
- **Program**
  - OBP JUONS
  - Quantity: Total 15 # OIF 0 # OEF
  - POC PM: Robert Rappold, PM LTV, DSN 786-2319
  - POC TARDEC: Andrew Schultz, Engineering, DSN 786-5075

- **Funding**

Event	Funding Request	Obligated	Remaining
Management	$175,000.00		
Engineering/Test	$350,000.00		
Integration	$20,000.00		
Documentation	$35,000.00		
Component Acquisition	$207,000.00		
Transport	$3,000.00		
Field Support	$70,000.00		
TOTAL	$860,000.00 (includes 15 kits)		
Production*	$177.8 M for 18669 vehicle kits		

Projected 1st KIT in Theater : 1 March 07 based on start date of 01 Nov. * Engineering estimate

- **Schedule:**



As of: 13 Nov 06

RG-31 OBVP (280A) Management Plan

- **Description:**
  - –280 Amp alternator upgrade with advanced pulley
  - –AC/DC Converter
- **Capability Gap**
  - – Current 100Amp alternator, 65 Amp at idle .
  - – min goal 173 Amp with a target of 200 Amp at idle.
- **Program**
  - – OBP JUONS
  - – Quantity: Total 5 # OIF 0 # OEF
  - –POC PM: Ross Boelke, PM AMS, DSN 786-8852
  - –POC TARDEC: Sean Tominna, Engineering, DSN 786-8909

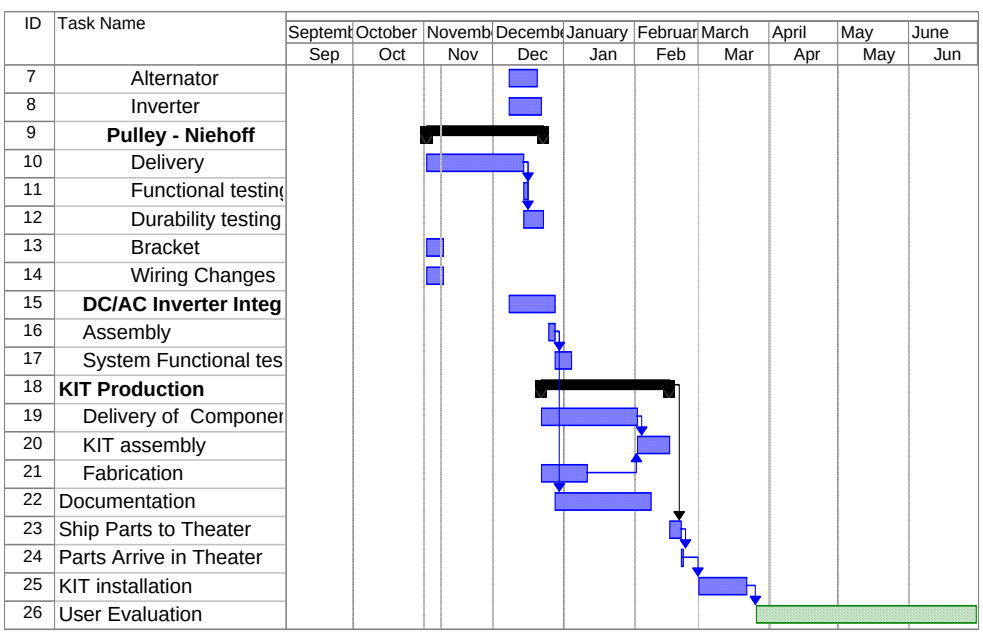
- **Funding**

Event	Budget	Obligated to date	Remaining
Management	$175,000.00		
Engineering/Test	$200,000.00		
Integration	$20,000.00		
Documentation	$14,800.00		
Component Acquisition	$107,000.00		
Transport	$3,000.00		
Field Support	$30,080.00		
TOTAL	$549,880.00 (includes 5 kits)		
Production*	$3.1M (includes 321 kits)		

Projected 1st KIT in Theater : 1 March 07 based on start date of 01 Nov.

* Engineering estimate

- **Schedule:**



As of: Date

Path Forward

- JRAC supported recommendations
- Funding received January 2007
- TARDEC executing program
  - Components identified
  - Technical integration issues resolved
  - Testing on-going at Yuma Proving Grounds
  - Fielding to theater for evaluation in May
- 2nd Phase RG-31 solution pending
- Funding for implementation deferred until field tests completed
- Lessons learned to be transitioned to USMC and JLTV programs

DISCUSSION