# SYSTEM SPECIFICATION

# FOR THE

# ADVANCED MOBILE INTEGRATED POWER SYSTEM

Version 1.1
21 November 2003
(AMPS SSS v11.doc)

Prepared for:

TARDEC
Advanced Mobile integrated Power System
Science and Technology Objective

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**Identification: This Specification establishes the system-level performance, design, development, and test requirements for the Advanced Mobile integrated Power System (AMPS) Science and Technology Objective (STO). System overview The purpose of the AMPS STO is to rapidly develop a configurable power system capable of supporting electrical power and power management requirements to integrate Vehicle Electronics (Vetronics), Command, Control, Communications, Computers Intelligence, Surveillance, and Reconnaissance (C4ISR), and embedded simulation capabilities into Future Combat Systems (FCS) platforms, including robotic Unmanned Ground Vehicles (UGVs). The AMPS technologies include ? Power Generation ? Energy Storage ? Smart Power Architecture ? Modeling and Simulation**

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| | | |
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# 1 SCOPE

## 1.1 Identification

This Specification establishes the system-level performance, design, development, and test requirements for the Advanced Mobile integrated Power System (AMPS) Science and Technology Objective (STO).

## 1.2 System overview

The purpose of the AMPS STO is to rapidly develop a configurable power system capable of supporting electrical power and power management requirements to integrate Vehicle Electronics (Vetronics), Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR), and embedded simulation capabilities into Future Combat Systems (FCS) platforms, including robotic Unmanned Ground Vehicles (UGVs). The AMPS technologies include:

- Power Generation
- Energy Storage
- Smart Power Architecture
- Modeling and Simulation

AMPS will allow integration and use of emerging commercially developed automotive systems and sub-systems (42VDC, 120 VAC, etc). Specific component technologies to be integrated include:

- Diagnostic Health Monitoring for Energy Storage
- Smart Batteries
- Integrated Starter-Alternator
- Fuel Cells
- Power Modules with BIT/BITE Capability
- Remote switching and power sub-system interface through CAN based multiplex systems
- Reusable Smart Switching Software

The AMPS will capitalize on prior and parallel research investments from the National Automotive Center (NAC) on Smart Batteries and Fuel Cells as well as commercial industry on power modules, alternators and 42V electrical components.

Technology from the AMPS STO will be able to support the Multifunction Utility/Logistics and Equipment Vehicle (MULE) UGV, FCS and Stryker Brigade Combat Team (SBCT) programs.

### 1.3 Document overview

This document conforms to the format and content preparation instructions of Data Item Description (DID) DI-IPSC-81431A, System/Subsystem Specification (SSS).

Section 1 of this SSS identifies the AMPS and provides a brief overview.

Section 2 provides a list of documents referenced in the body of this specification.

Section 3 specifies the system level requirements for the AMPS.

Section 4 specifies the method(s) to be used to ensure each requirement of Section 3 has been satisfied.

Section 5 provides requirements traceability (AMPS SSS to Source Document) for Section 3 requirements.

Section 6 contains a list of acronyms and abbreviations used in this SSS.

Section 7 (Appendix A) identifies future requirements for the AMPS STO.

# 2 REFERENCED DOCUMENTS

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered the superseding requirement.

## 2.1 Government documents

SPECIFICATIONS:

Federal

Military

Other Government Agency

STANDARDS:

Federal

Military

| | |
|---|---|
| MIL-STD-461E<br>20 August 1999 | Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment |
| MIL-STD-462D<br>Notice 4<br>20 August 1999 | Test Method Standard for Measurement of Electromagnetic Interference Characteristics |
| MIL-STD-464<br>18 March 1997 | Electromagnetic Environmental Effects Requirements for Systems |
| MIL-STD-810F<br>Notice 1<br>1 November 2000 | Environmental Engineering Considerations and Laboratory Tests |
| MIL-STD-882D<br>10 February 2000 | Standard Practice for System Safety |

| | |
|---|---|
| MIL-STD-1275B<br>20 November 1997 | Characteristics of 28 Volt DC Electrical Systems in Military Vehicles |
| MIL-STD-1472F<br>23 August 1999 | Human Engineering |
| MIL-STD-1474D<br>Notice 1<br>20 August 1997 | Noise Limits |

Other Government Agency

DRAWINGS:

OTHER PUBLICATIONS:

Manuals

Regulations

Handbooks

| | |
|---|---|
| MIL-HDBK-759C<br>Notice 2<br>31 March 1998 | Human Engineering Design Guidelines |

Bulletins

Miscellaneous

| | |
|---|---|
| DI-IPSC-81431A<br>10 January 2000 | Data Item Description (DID), System/Subsystem Specification |
| FCS ORD<br>30 August 2002 | Operational Requirements Document for the Future Combat Systems |
| JTA-Army<br>Version 6.5<br>10 May 2002 | Department of the Army Joint Technical Architecture – Army (JTA-Army) |
| Stryker ORD<br>Revision 1 | Operational Requirements Document for a Family of Stryker Vehicles |

| | |
|---|---|
| Stryker Performance Specification | IAV Performance Specification at Initial Delivery |
| Vetronics Reference Architecture (VRA) Draft Version 1.0 1 October 2001 | Vehicle Electronics (Vetronics) Reference Architecture (VRA) |

## 2.2 Non-Government documents

SPECIFICATIONS:

STANDARDS:

| | |
|---|---|
| ISO 11898 | Road vehicles -- Controller area network (CAN) |
| ISO/WD 21848 | Electrical and Electronic Equipment for a 42 V Network -- Electrical Loads |

DRAWINGS:

| | |
|---|---|
| 786-30000 Version --.14 | Future Combat Systems (FCS) Common Requirements Manned Ground Vehicle |
| 786-30024 | Future Combat Systems (FCS) Multifunction Utility/Logistics and Equipment (MULE) Vehicle Procurement Control Drawing (PCD) |
| S786-51.210 | Future Combat Systems (FCS) Real Time Common Operating Environment Software Requirement Specification |

OTHER PUBLICATIONS:

| | |
|---|---|
| NFPA 70(02)SB | National Electric Code |

# 3 REQUIREMENTS

## 3.1 Required states and modes

The operational functionality of the AMPS is described using modes and states as a method of partitioning the system. The definitions of mode, state, transition, and capability used in defining the AMPS are given below:

**Mode** - A mode is a stable condition of the system, during which certain specified functionality is available (e.g. Combat Mode). Modes differ from each other only in the lists or combinations of functionality enabled in each mode. Modes are defined to include or exclude certain specific functionality. Each mode contains one or more related states.

**State** - A state is a stable condition within a system mode, during which certain specified functionality is available (e.g. System Startup State is available within the Combat Mode). States differ from each other only in the lists or combinations of functionality enabled in each state. States are defined to include or exclude certain specific functionality.

**Transition** - The system will transition from one mode to another mode only by the occurrence of an event (e.g. action by an operator or automatically through some other invoked process). In particular, only the events defined in the System Mode Transition Diagram (Figure 3.1-1) are allowed to change the current mode of the system. An event is defined as a single input or combination of inputs. During transition from mode to mode, the system may perform an action. An action is defined as a single output or combination of outputs that are unique to a particular transition.

**Capability** - A "Capability" is a grouping of related requirements. The mapping of capabilities to modes and states will not necessarily be unique (i.e. the same capability may be found in more than one mode or state).

The AMPS contains the following system modes:

a) Operational Mode – "Normal" operating mode of the AMPS where all capabilities and interfaces are fully available

b) Degraded Mode – Entered automatically upon encountering failures that reduce AMPS performance characteristics to less than full performance (still mission capable)

c) Residual Mode – Entered from the Degraded Mode when AMPS performance drops below minimum degraded thresholds (mission must be aborted)

d) Training Mode – Supports in-garrison and field training exercises including battlefield visualization and mission rehearsal capabilities and allows operations in "simulated" Operational, Degraded, and Residual modes

The System Mode Transition Diagram is shown in Figure 3.1-1 and defines the AMPS system modes and transitions.

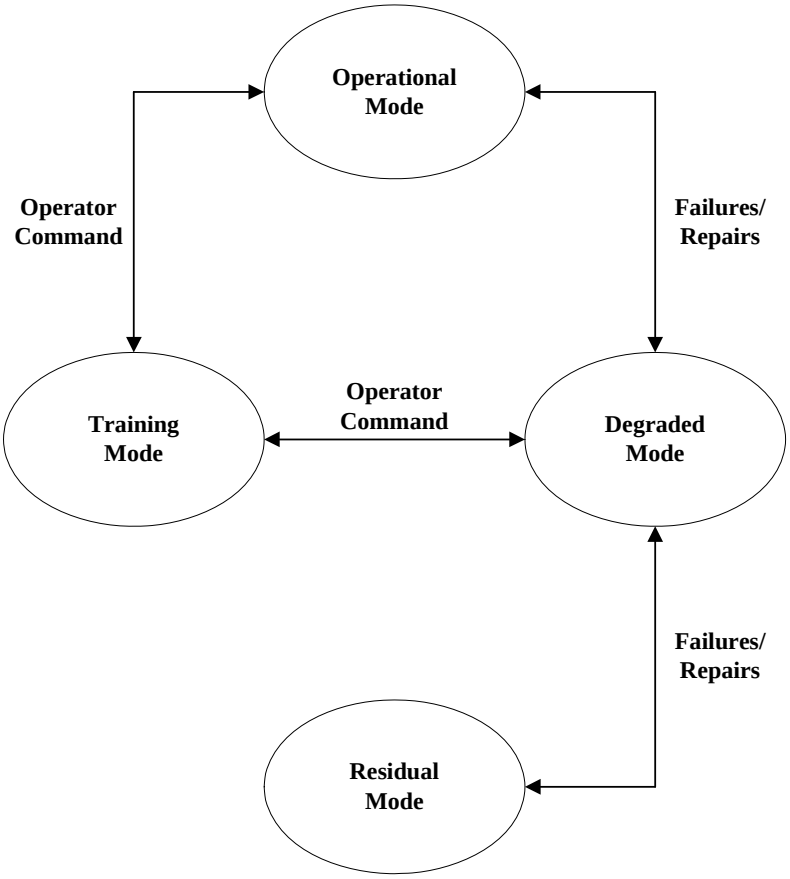


Figure 3.1-1. System Mode Transition Diagram

Each AMPS system mode (Operational, Degraded, Residual, and Training) is further broken down into a number of lower level modes. These lower level modes along with the states available in these modes are defined in Tables 3.1-1 through 3.1-3. Training mode has the same Mode/State definitions as Operational mode with required lockouts to maintain training safety standards.

Table 3.1-1. AMPS Operational Modes/States Matrix

| AMPS Applicable FCS Operational States | Crew Selectable Modes | | | | | Vehicle Configuration Modes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Combat Mode | Silent Mode | Planning Mode | Maintenance Mode | Fording Mode | Transit Mode | Cold Ops Mode | Protection Enhancement Mode | MOPP Mode | Sustainment Mode |
| | | | | | | | | | | |
| System Startup | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | |
| Prime Power Source Online | X | | X | X | X | | X | X | X | X |
| | | | | | | | | | | |
| Auxiliary Power Source Online | X | X | X | X | X | | X | X | X | X |
| | | | | | | | | | | |
| Umbilical C4ISR Power | | | | X | | X | | | | |
| | | | | | | | | | | |
| Umbilical Mobility Power | X | X | | X | X | | X | X | X | |
| | | | | | | | | | | |
| Vetronics On | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | |
| System Shutdown | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | |
| **Notes:** | **X = Full Function Performance** | | | | | | | | | |

Table 3.1-2. AMPS Degraded Modes/States Matrix

| AMPS Applicable FCS Degraded States | Crew Selectable Modes | | | | | Vehicle Configuration Modes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Combat Mode** | **Silent Mode** | **Planning Mode** | **Maintenance Mode** | **Fording Mode** | **Transit Mode** | **Cold Ops Mode** | **Protection Enhancement Mode** | **MOPP Mode** | **Sustainment Mode** |
| System Startup | X | X | X | X | X | X | X | X | X | X |
| Prime Power Source Online | D | | D | D | D | | D | D | D | D |
| Auxiliary Power Source Online | D | D | D | D | D | | D | D | D | D |
| Umbilical C4ISR Power | | | | X | | X | | | | |
| Umbilical Mobility Power | D/X | D/X | | D/X | D/X | | D/X | D/X | D/X | |
| Vetronics On | X/D | X/D | X/D | X/D | X/D | X/D | X/D | X/D | X/D | X/D |
| System Shutdown | X | X | X | X | X | X | X | X | X | X |
| **Notes:** | **X = Full Function Performance**<br>**D = Degraded Function Performance** | | | | | | | | | |

Table 3.1-3. AMPS Residual Modes/States Matrix

| AMPS Applicable FCS Residual States | Crew Selectable Modes | | | | | Vehicle Configuration Modes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Combat Mode | Silent Mode | Planning Mode | Maintenance Mode | Fording Mode | Transit Mode | Cold Ops Mode | Protection Enhancement Mode | MOPP Mode | Sustainment Mode |
| | | | | | | | | | | |
| System Startup | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | |
| Prime Power Source Online | R | | | | | | R | R | R | |
| | | | | | | | | | | |
| Auxiliary Power Source Online | R | | | | | | R | R | R | |
| | | | | | | | | | | |
| Umbilical C4ISR Power | | | | | | | | | | |
| | | | | | | | | | | |
| Umbilical Mobility Power | | | | | | | | | | |
| | | | | | | | | | | |
| Vetronics On | R | | | | | R | R | R | R | |
| | | | | | | | | | | |
| System Shutdown | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | |
| **Notes:** | **X = Full Function Performance**<br>**R = Residual Function Performance Maintained** | | | | | | | | | |

### 3.1.1 AMPS system modes

The paragraphs that follow further define each AMPS lower level system mode. Definitions were derived from FCS system documentation.

#### 3.1.1.1 Combat mode

The Combat Mode provides full-up capabilities of the intrinsic C4ISR, lethality, platform protection, automotive, and auxiliary system functions required for the AMPS host vehicle to carry out its intended mission. The Combat Mode supports mobile and stationary operations defined by the appropriate collection of states. The states that are generally associated with the Combat Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.2 Silent mode

The Silent Mode provides for silent watch and silent mobile operations where the principal objective is offensive and defensive surveillance operations. The AMPS host vehicle can be placed into a basic silent watch or silent mobile state with a single control input. Other silent states are possible and can be selected by the host vehicle. The states that are generally associated with the Silent Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.3 Planning mode

The Planning Mode is used for assembly area operations (before combat engagement) where planning and equipment checks take place. When the Planning Mode is selected, the AMPS host vehicle is configured to allow easy system checks, facilitate built-in-test (BIT) operations, and allow planning activities through network connectivity as-well-as host vehicle intrinsic planning assets. The states that are generally associated with the Planning Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.4 Maintenance mode

The Maintenance Mode allows the AMPS host vehicle to be configured to facilitate more extensive BIT for maintenance/repair purposes. Host vehicles are expected to perform certain levels of unscheduled repairs and maintenance during the conduct of missions. The states that are generally associated with the Maintenance Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.5 Fording mode

The Fording Mode automatically reconfigures the AMPS host vehicle to support fording operations. Examples of potential automatic reconfigurations that may be initiated by this mode include deploying inlet/exhaust extensions to prevent water entrainment/ingestion, power management adjustments to conserve power and protect

equipment, air flow adjustments necessary to accommodate potential air flow schedule adjustments, etc. The states that are generally associated with the Fording Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.6 Transit mode

The Transit Mode invokes those systems that are necessary to support en route mission planning and rehearsal (EMPRS) activities. This mode typically requires physical AMPS host vehicle configuration changes such as umbilical connections and special power management support. The states that are generally associated with the Transit Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.7 Cold operations mode

The Cold Operations Mode allows the AMPS host vehicle to be successfully operated in extreme cold environments. This mode is made possible by installing a winterization kit on the host vehicle. The states that are generally associated with the Cold Operations Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.8 Protection enhancement mode

In some instances it may be necessary to provide protection enhancements (additional armor, signature enhancements, etc.) to the AMPS host vehicle once it arrives in the field. The protection enhancement kit is used for this purpose. Once installed, host vehicle performance requirements will be associated with the Protection Enhancement Mode. The states that are generally associated with the Protection Enhancement Mode are shown in Tables 3.1-1 through 3.1-3.

#### 3.1.1.9 MOPP mode

The Mission-Oriented Protective Posture (MOPP) Mode allows the AMPS host vehicle to be successfully operated in the presence of a NBC environment threat. Once the sealed host vehicle environment is violated, the crew will be required to perform their required functions while wearing MOPP gear. Once this gear is donned, host vehicle performance requirements will be associated with the MOPP Mode. The states that are generally associated with the MOPP Mode are shown in Tables 3.1-1 through 3.1-3.

### 3.1.1.10 Sustainment mode

The Sustainment Mode allows the sensors to acknowledge the addition of consumables to replenish the system, update the status of added consumables, and report the current status of onboard consumables through the Platform Soldier-Mission Readiness System (PS-MRS) and the Logistics Decision Support System (LDSS) to update the COP. The states that are generally associated with the Sustainment Mode are shown in Tables 3.1-1 through 3.1-3.

## 3.1.2 AMPS states

Table 3.1.2-1 below contains definitions for each of the AMPS system states. Definitions were derived from FCS system documentation.

Table 3.1.2-1 AMPS State Definitions

| State # | AMPS State | Definition |
|---|---|---|
| | | |
| 1. | System Startup | Supports the power-up operations. It ensures that the vehicle is properly configured and functional to enter the combat mode when powered up. |
| 2. | Prime Power Source Online | The prime power source is allowed to operate as required to support vehicle power management demands. |
| 3. | Auxiliary Power Source Online | The vehicle gets its power from the source designed to support silent mode operations. |
| 4. | Umbilical C4ISR Power | Allows key C4ISR vehicle systems to be powered through an external umbilical to support EMPRS and maintenance operations. |
| 5. | Umbilical Mobility Power | Allows key mobility elements to be powered through an external umbilical to support vehicle recovery operations. |
| 6. | Vetronics On | Characterized by all the functions necessary to operate/manage the vehicle systems, monitor system health, navigate, and interface with crew stations. |
| 7. | System Shutdown | Supports the power-down operations. It ensures that the vehicle is properly configured to exit the current mode when powered down. |
| | | |

### 3.2 System capability requirements

The purpose of the AMPS STO is to rapidly develop a configurable power system capable of supporting electrical power and power management requirements to integrate Vehicle Electronics (Vetronics), Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR), and embedded simulation capabilities into Future Combat Systems (FCS) platforms, including robotic Unmanned Ground Vehicles (UGVs). The AMPS technologies include:

- Power Generation
- Energy Storage
- Smart Power Architecture
- Modeling and Simulation

#### 3.2.1 General

The AMPS shall [1] provide all the electrical power and energy needs to support a particular combat vehicle's mission, including silent run, silent watch, and all the added mission packages. The AMPS system shall [2] be highly efficient, lightweight, low volume, and have a 25% added power reserve for future needs.

The AMPS [3] shall sustain the electrical requirements of digital technologies without running the host platform's engine and at the same time emit very low levels of acoustic and thermal signatures. The AMPS shall [4] be capable of providing continuous power to avoid loss of all system data during power outages.

The AMPS shall [5] be adaptable to standard worldwide commercial alternating current power (120 volts/60 hertz and 220 volts/50 hertz). AMPS equipment shall [6] meet the applicable requirements of the National Electrical Code, NFPA 70-02.

#### 3.2.2 Power generation

Combinations of internal and external AMPS power sources shall [1] provide for host vehicle operation for a minimum of 7-days (Threshold) and a maximum of 30-days (Objective) under tactical conditions. Host vehicle platform Vetronics, C4ISR system and embedded training sub-systems (including mission planning and rehearsal) shall [2] be capable of operating without the engine running using either external electric power

(commercial or standard Army generator) provided through an externally mounted junction box or on-board power source(s).

The AMPS shall [3] be equipped with DC (28VDC IAW MIL-STD-1275 and 42VDC IAW with ISO/WD 21848) and AC (110/220V, 50/60Hz) power generation capabilities. For 28 VDC power generation, the AMPS shall [4] operate in accordance with the fault free and single fault characteristics specified in MIL-STD-1275.

The AMPS shall [5] be capable of transitioning between on board power sources without any loss of functionality. The AMPS shall [6] provide for electrical isolation between any AC voltage buses and grounded DC voltage buses. The AMPS shall [7] provide protection from voltage reversals, open circuits, short circuits, and arcing.

AMPS power sources shall [8] not generate thermal, electromagnetic, or acoustic signatures that are easily detectable from a distance greater than 10 meters.

#### 3.2.2.1 Smart alternator

The Smart Alternator shall [1] be programmable to supply optimum charging currents to Ultra-capacitors, Fuel Cell Electrolyzers, and several different technologies of batteries. The Smart Alternator shall [2] provide a temperature compensated charging capability.

The Smart Alternator shall [3] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. The Smart Alternator shall [4] be capable of supplying 14, 28, and 42 volt electrical power.

#### 3.2.2.2 Fuel cell

The Vehicle Integrated Multi-service Regenerative Electrolyzer Fuel cell (VI-MREF) base concept system shall [1] weigh no greater than 140 kg. The VI-MREF shall [2] be designed to physically fit into a standard 130L battery compartment.

The VI-MREF shall [3] be capable of delivering up to 6 kW of instantaneous (cranking) power. The VI-MREF shall [4] deliver 6 to 20 hours of operation within the range of high function (2 kW) down to minimum (800 W) power conditions. Additional space of a second 130L battery compartment shall [5] allow the VI-MREF to support 12 to 40 hours of operation.

The VI-MREF shall [6] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface.

#### 3.2.2.3 Integrated starter/alternator

The Integrated Starter/Alternator (ISA) shall [1] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface.

### 3.2.3 Energy storage

Combinations of internal and external AMPS energy sources shall [1] provide for host vehicle operation for a minimum of 7-days (Threshold) and a maximum of 30-days (Objective) under tactical conditions. AMPS on-board energy sources shall [2] be rechargeable and replaceable.

The AMPS shall [3] support a host vehicle silent watch mode allowing operation of electrically powered ISR/TA payloads and other mission critical C4ISR capabilities without running the platform engine (minimum thermal and acoustic signature emissions) for a minimum of 8 hours (Threshold) and a maximum of 12 hours (Objective).

The AMPS shall [4] be capable of performing battery recharging in support of both mounted and dismounted infantry squads. The AMPS shall [5] enable an 80% increase in energy storage density and twice the normal life of current US Army standard batteries.

AMPS energy storage devices shall [6] not generate thermal, electromagnetic, or acoustic signatures that are easily detectable from a distance greater than 10 meters.

#### 3.2.3.1 Smart battery

The Smart Battery shall [1] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. At a minimum, the Smart Battery status shall [2] include the following parameters:

a) State of Charge
b) State of Health
c) Run Time Until Empty
d) Run Time to Start
e) Run Time Till Full
f) Battery Voltage
g) Battery Current
h) Battery Temperature

#### 3.2.3.2 Ultra-Capacitor

The Ultra-Capacitor shall [1] boost cold starting capability of a diesel engine vehicle at a temperature of –25 F degrees. The Ultra-Capacitor shall [2] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface.

### 3.2.4 Smart power architecture

The AMPS shall [1] include a "Smart" power architecture that is capable of providing uninterrupted power required to operate the mission critical equipment of the host vehicle. The AMPS shall [2] manage electrical power distribution and utilization and monitor and protect power system and loads.

The AMPS shall [3] be capable of controlling and monitoring Remote Power Controllers (RPCs). The AMPS shall [4] include power sensing and stored energy management. The AMPS shall [5] be capable of dynamic load prioritization and shedding load selection.

The AMPS shall [6] provide host vehicle electrical system status information to the crew and maintenance personnel. The status information shall [7] include electrical faults or problems, battery charge, battery life remaining at present load, battery pack health, alternator health, and alternator current output.

The AMPS shall [8] contain a standard NATO electrical slave receptacle. The NATO slave receptacle shall [9] support:

a) Re-charging of all AMPS/host vehicle batteries
b) Powering the host vehicle with an external power source
c) "Slave" starting the host vehicle
d) Powering standard tools and diagnostic equipment

### 3.2.5 Modeling and simulation

The AMPS STO shall [1] develop a ground vehicle electrical system modeling and simulation tool. The modeling and simulation tool shall [2] be capable of:

a) Providing highly accurate estimates of vehicle power consumption

b) Determining the power required for various mission scenarios
c) Calculating silent watch durations for a given subset of vehicle equipment
d) Providing a simulation capability to determine minimum/average/typical/peak power consumption
e) Considering vehicle environmental conditions (temperature, humidity, shock, vibration, etc.) on both the power generating equipment and energy storage devices
f) Considering automotive constraints (engine RPM, engine and/or APU fuel consumption, etc.)
g) Analyzing vehicle degraded modes of operation (e.g. what happens if APU fails?)
h) Exporting results to MS Office applications (Excel, PowerPoint, etc.)
i) Performing transient simulations of voltages and currents at the power system component level

The modeling and simulation tool shall [3] accept the following as inputs:

a) Vehicle electrical load parameters (minimum/average/typical/peak) for each LRU in the vehicle (include a database of standard Army equipment)
b) Vehicle Battery characteristics and parameters
c) Vehicle Alternator characteristics and parameters
d) Vehicle APU characteristics and parameters (if present)
e) Vehicle Inverter characteristics and parameters (if present)
f) Vehicle automotive characteristics (engine RPM, fuel capacity, etc.)
g) Vehicle operating temperature range
h) Power capacity requirements for reserve and growth

The modeling and simulation tool shall [4] provide the following as outputs:

a) Minimum/Average/Typical/Peak vehicle power consumption
b) Minimum/Average/Typical/Peak vehicle power reserve
c) Estimated silent watch duration
d) Estimated average battery life (size the battery bank for the amount of Amp-Hours required based on specific requirements)
e) APU and Generator capacity required plus the reserve capacity for future growth

### 3.2.6 System capability relationships

Table 3.2.6-1 maps the capabilities defined in 3.2 to the system states and modes described in 3.1.

Table 3.2.6-1. AMPS Mode - Capability Matrix

| Paragraph | Capability | Crew Selectable Modes | | | | | Vehicle Configuration Modes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Combat Mode | Silent Mode | Planning Mode | Maintenance Mode | Fording Mode | Transit Mode | Cold Ops Mode | Protection Enhance Mode | MOPP Mode | Sustainment Mode |
| 3.2 | **System capability requirements** | | | | | | | | | | |
| 3.2.1 | **General** | X | X | X | X | X | X | X | X | X | X |
| 3.2.2 | **Power generation** | X | | X | X | X | | X | X | X | X |
| 3.2.3 | **Energy storage** | X | X | X | X | X | | X | X | X | X |
| 3.2.4 | **Smart power architecture** | X | X | X | X | X | X | X | X | X | X |
| 3.2.5 | **Modeling and simulation** | X | X | X | X | X | X | X | X | X | X |
| Legend: | X = Capability is required (or available) in the corresponding state or mode | | | | | | | | | | |

## 3.3 System external interface requirements

### 3.3.1 Interface identification and diagrams

External interfaces for the AMPS will include a Host System Integration interface, a Host Propulsion System interface, DC Output Power interface, a NATO Slave interface, and an interface for Test and Maintenance purposes. The AMPS External Interface Diagram is shown in Figure 3.3.1-1.

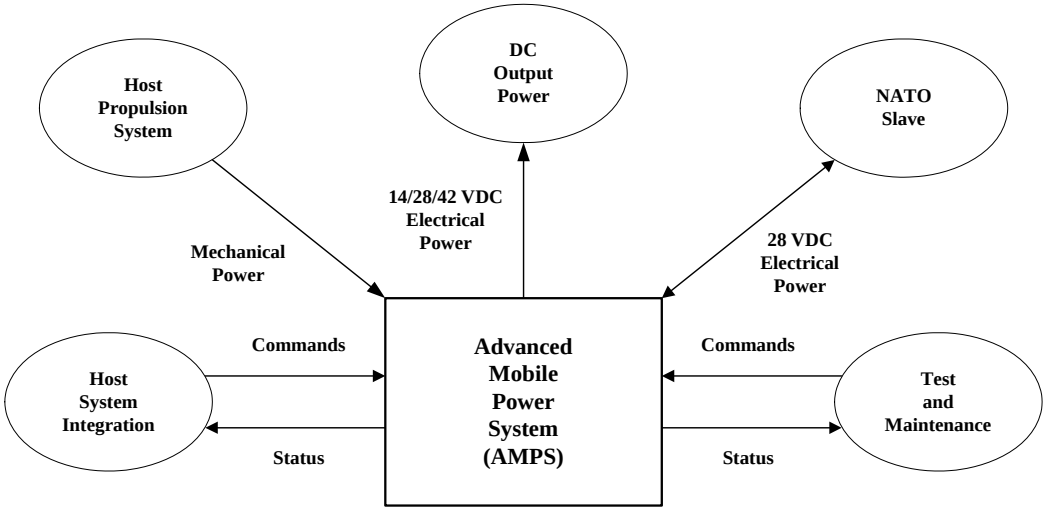


Figure 3.3.1-1. AMPS External Interface Diagram

### 3.3.2 Host system integration interface

The Host System Integration interface shall [1] provided a command/status type interface to facilitate the integration of AMPS into the host vehicle platform. The AMPS "Smart" Power Architecture shall [2] accessible through this interface.

### 3.3.3 Host propulsion system interface

The Host Propulsion System interface shall [1] provide the mechanical power required by AMPS power generation and energy storage components.

### 3.3.4 DC output power interface

The DC Output Power interface shall [1] supply the 14, 28 and 42 VDC power required by the host vehicle platform. The DC power provided by this interface shall [2] be managed by the AMPS "Smart" Power Architecture.

### 3.3.5 NATO slave interface

The AMPS shall [1] be equipped with a standard NATO slave interface. At a minimum the NATO slave interface shall [2] support:

a) Re-charging of all AMPS/host vehicle batteries
b) Powering the host vehicle with an external power source
c) "Slave" starting the host vehicle
d) Powering standard tools and diagnostic equipment

### 3.3.6 Test and maintenance interface

The AMPS shall [1] provide a Test and Maintenance (T&M) interface. At a minimum, the T&M interface shall [2] support:

a) Fault isolation and repair
b) Software downloading
c) Data logging

## 3.4 System internal interface requirements

System internal interface requirements for the AMPS shall [1] comply with the applicable portions of the Joint Technical Architecture-Army (JTA-Army) and the Vetronics Reference Architecture (VRA).

## 3.5 System internal data requirements

System internal data requirements for the AMPS shall [1] comply with the applicable portions of the Joint Technical Architecture-Army (JTA - Army) and the Vetronics Reference Architecture (VRA).

### 3.5.1 Data logging

The AMPS shall [1] provide a data logging capability to gather and archive internal operational and maintenance (sustainment) data. The logged data shall [2] be accessible through the AMPS test and maintenance interface.

### 3.6 Adaptation requirements

There are no installation-dependent or operational-dependent data requirements for the AMPS.

### 3.7 Safety requirements

The AMPS shall [1] not have any uncontrolled safety or health hazards (including noise, excessive heat, and toxic fumes) that may adversely impact upon the health or safety of the operator, maintainer, trainer, or handler. Priority shall [2] be given to eliminating or reducing, to an acceptable level of risk, hazards through design considerations with the use of Warnings, Cautions, and Alerts (WCAs) as a last resort.

Deleted: IAV

Emergency controls shall [3] be easily identifiable. Emergency controls shall [4] provide clear indication of the appropriate action required in the event of an emergency. MIL-STD-882 shall [5] be used as a guide.

#### 3.7.1 Warnings, cautions and alerts

The AMPS shall [1] have the capability to automatically generate Warnings, Cautions, and Alerts (WCAs) when conditions warrant. WCAs shall [2] be defined as follows:

a) Warnings – a condition that could result in death or injury to personnel
b) Cautions – a condition that could result in damage to the equipment
c) Alerts – a condition that the vehicle crew should be made aware

Warnings shall [3] take priority over Cautions and Alerts. Cautions shall [4] take priority over Alerts. WCAs shall [5] be capable of generating audible and/or visual alarms. The current status of all WCAs shall [6] be included in the AMPS data log.

### 3.8 Security and privacy requirements

The AMPS shall [1] have a zeroize function capable of the permanent erasure of all sensitive digitally stored information.

### 3.9 System environment requirements

#### 3.9.1 Environmental conditions

The AMPS and associated subsystems shall [1] have ruggedized features that protect against environmental vulnerabilities during host platform movement at all speeds over all terrain. The AMPS shall [2] operate in conditions including, but not limited to, snow, moderate ice, rain, sand, dust, salt water spray and when exposed to battlefield contaminants. The system will be transported and operated in induced environments such as vibration, shock, and rail impact.

The AMPS shall [3] meet or exceed specified safety and performance requirements after exposure to natural and induced environments described below.

##### 3.9.1.1 Natural environment

###### 3.9.1.1.1 Temperature

The AMPS shall [1] operate in ambient temperatures ranging from -35 to +140 degrees Fahrenheit (-37 to +60 degrees Centigrade).

The AMPS shall [2] survive extended storage periods in ambient temperatures ranging from –50 to +160 degrees Fahrenheit (-46 to +71 degrees Centigrade).

The use of winterization kits is permissible to support operations below -25 degrees Fahrenheit (-32 degrees Centigrade).

###### 3.9.1.1.2 Humidity

The AMPS shall [1] be capable of operation and storage while being exposed to 0 to 100% relative humidity.

###### 3.9.1.1.3 Altitude

The AMPS shall [1] be capable of withstanding, without preparation or any degradation in performance, the altitude requirements of MIL-STD-810.

The AMPS shall [2] be capable of storage and operation at “cabin” altitudes up to 15,000 feet or 8.3 psia as per MIL-STD-810.

#### 3.9.1.1.4 Salt fog

The AMPS shall [1] operate without performance degradation during and after exposure to a salt fog concentration of 5±1 percent for 48 hours as per MIL-STD-810.

#### 3.9.1.1.5 Lightning

The AMPS shall [1] remain operational after a lightening strike without adverse impact to the vehicle or crew.

### 3.9.1.2 Induced environment

#### 3.9.1.2.1 Shock

The AMPS shall [1] be capable of withstanding high levels of induced shock encountered during various modes of operation and transport including traversing difficult cross country terrain, and transport on fixed wing aircraft.

The AMPS shall [2] withstand the rail impact test specified in MIL-STD-810 without degradation or damage.

#### 3.9.1.2.2 Vibration

The AMPS shall [1] operate without performance degradation or damage from the effects of vibration during the conduct of a mission or during transport.

#### 3.9.1.2.3 Chemical, biological, radiological and nuclear

The AMPS shall [1] be hardened against the material damaging effects of Chemical, Biological, Radiological, and Nuclear (CBRN) and chemical/toxic industrial material contaminants and decontaminants.

The AMPS shall [2] survive initial nuclear radiation (INR), blast, thermal effects such that all essential mission functions are operational within the host vehicle initialization times.

#### 3.9.1.2.4 Electromagnetic environment effects

##### 3.9.1.2.4.1 EMI/EMC

The AMPS shall [1] be Electromagnetic Compatible (EMC) and must not cause disruptive EMI (per MIL-STD-461, MIL-STD-462 and MIL-STD-464) nor post a hazard to any existing or proposed ordnance system.

#### 3.9.1.2.4.2 HEMP

The AMPS shall [1] be able to support critical mission functions of the host vehicle while in NBC contaminated environments and within 15 minutes following High-altitude Electromagnetic Pulse Environments (HEMP).

#### 3.9.1.2.4.3 Grounding, bonding and shielding

AMPS electrical and electronic equipment enclosures shall [1] be grounded to the vehicle structure. Electrical harnesses shall [2] contain an overall shield bonded to the backshell of each harness connector.

All design components that include sensitive electronics elements shall [3] include appropriate enclosures, bonding and grounding to protect them from Electro-Static Discharge (ESD) from human contact.

The AMPS shall adhere [4] to the system grounding guidelines contained in the VRA.

#### 3.9.1.2.5 Noise levels

Maximum noise levels for the AMPS shall [1] be within the guidelines specified by MIL-STD-1474.

### 3.10 Computer resource requirements

The AMPS system design approach shall [1] comply with the applicable portions of the Joint Technical Architecture - Army (JTA - Army). Any proposed technical designs that deviate from the standards and practices delineated in the JTA - Army shall [2] be approved by the Army Digitization Office (ADO) prior to implementation.

The AMPS System Architecture shall [3] also comply with the applicable recommendations of the Vetronics Reference Architecture (VRA) and the Joint Architecture for Unmanned Systems (JAUS).

### 3.10.1 Computer hardware requirements

Computer hardware for the AMPS shall [1] comply with the applicable portions of the JTA-Army and the Vetronics Reference Architecture (VRA).

### 3.10.2 Computer hardware resource utilization requirements

At the time of AMPS delivery, processor and memory utilization (calculated as total capacity used divided by total capacity available) shall [1] be 75% or less.

### 3.10.3 Computer software requirements

Computer software for the AMPS shall [1] comply with the applicable portions of the JTA-Army and the VRA. Functional application computer software developed shall [2] use a DoD approved software programming language unless appropriate waivers are obtained.

Computer software developed or provided shall [3] be consistent with the Real Time Operating Environment specified in Boeing Document S786-51.210, "Real Time Common Operating Environment Software Requirement Specification".

#### 3.10.3.1 Reprogramming

The AMPS shall [1] have the capability to reprogram onboard software from an external device (e.g. Laptop Computer, Software Loader/Verifier (SL/V), Mission Data Loader (MDL), etc.). Reprogramming shall [2] provide the capability to program all devices with AMPS developed software. Each device with AMPS developed software shall [3] provide the reprogramming device, the currently loaded:

a) Software module name
b) Version number
c) Date of last download

### 3.10.4 Computer communications requirements

Computer communications for the AMPS shall [1] comply with the applicable portions of the JTA-Army and the VRA.

AMPS computer communications shall [2] be commercial standards based, modular in design, and scalable to meet new requirements.

### 3.11 System quality factors

#### 3.11.1 Reliability

The reliability of the AMPS shall [1] be consistent with the FCS host vehicle requirement for an Operational Readiness Rate of 95% (Threshold) and 99% (Objective). Operational Readiness is determined as the percent of systems and GFE available during a certain specified rating period.

In addition, the reliability of the AMPS shall [2] be consistent with the FCS host vehicle requirements for:

a) Mean Time Between System Abort (MTBSA) or failures that deadline the host platform, result in unsafe operation, or make it non-mission capable. The FCS MULE has an MTBSA requirement of 1148 hours minimum.

b) Mean Time Between Essential Function Failure (MTBEFF) or failures that results in host system degradation. The FCS MULE has an MTBEFF of 287 hours minimum.

c) Mean Time Between System Abort –Mobility (MTBSA-M) or failures that affect the host platform's mobility system, resulting in unsafe operation, or making it non-combat capable. FCS MTBSA-M for a 72 hour, high OPTEMPO mission pulse must be greater than or equal to 6450 hours.

#### 3.11.2 Maintainability

The AMPS shall [1] be designed for ease of maintenance and repair by using Line Replacement Units (LRUs)/Line Replacement Modules (LRMs) and Shop Replacement Units (SRUs). LRUs/LRMs are defined as any part or component that is replaceable by field maintenance personnel.

In addition, the maintainability of the AMPS shall [2] be consistent with the following FCS host vehicle requirements:

a) Maintenance Ratio (MR) must not exceed 0.05 Maintenance Man Hours/Operating Hour (MMH/OH).

b) Platform crews must be able to repair/replace at least 80% of System Aborts (SA), 80% Essential Function Failures (EFF), and 80% of Non- Essential Function Failures (NEFF) without the use of any special tools or support equipment.

c) Mean Time To Repair (MTTR) must not exceed 0.5 hours.

d) Each FCS system must provide the capability for automated Preventive Maintenance Checks and Services (PMCS).

The AMPS shall [3] incorporate both embedded prognostics and embedded diagnostics that detect and isolate faults to the individual LRU/LRM/SRU level. Prognostics and diagnostics shall [4] provide the level of detection and isolation required to meet the stated reliability requirements stated in Paragraphs 3.11.1.

The use of stand-alone test equipment shall [5] be minimized. The use of embedded prognostics and diagnostics shall [6] be maximized.

The AMPS design shall [7] minimize the number of distinct electrical connectors interfacing with internal LRUs/LRMs and the vehicle host platform. Electrical and electronic connectors to be used within the AMPS shall [8] be "keyed" to help ensure proper mating with the proper LRU/LRM.

#### 3.11.2.1 Prognostics

The AMPS shall [1] incorporate an embedded prognostics capability that will predict with 0.90 probability a critical system failure (any failures causing host vehicle system or mobility aborts) to the appropriate LRU/LRM that has a 50% or higher chance of occurrence in the succeeding 96 hours.

#### 3.11.2.2 Diagnostics

The AMPS shall [1] incorporate embedded diagnostics that can detect 99% of all detectable failures/faults with no more than 5% error rate (false alarm or missed failures/faults). The diagnostics shall [2] be able to isolate:

a) To one LRU/LRM 95%, ambiguity group of 1
b) To two or less LRUs/LRMs 97%, ambiguity group of 2
c) To three or less LRUs/LRMs 99 %, ambiguity group of 3

### 3.12 Design and construction constraints

#### 3.12.1 Materials, parts and processes

No radioactive or asbestos materials shall [1] be used in the manufacture or assembly of the AMPS such that any part of any component of the AMPS retains any of these materials, excluding GFE. No ozone-depleting substances shall [2] be used in the manufacture, assembly, or are required for the sustainment of the AMPS.

#### 3.12.2 Government property

Not applicable.

#### 3.12.3 Programming language

AMPS computer software programming language usage shall [1] comply with the applicable portions of the JTA-Army and the VRA.

#### 3.12.4 Physical characteristics

##### 3.12.4.1 Weight

The weight of the AMPS shall [1] be consistent with the weight constraints of the host vehicle including transport by C-130 (cannot exceed 32,000 pounds total weight, axle load of 13,000 pounds, or a tire pressure of 100 pounds per square inch) (3 to 9 MULE platforms per C-130), CH-47 (1 to 3 MULE platforms per CH-47), and UH-60 (gross vehicle weight of 5,000 pounds maximum) (one MULE platform per UH-60).

##### 3.12.4.2 Dimensions

The physical dimensions of the AMPS shall [1] be consistent with the available mounting space for power generation and distribution components within the host vehicle.

### 3.13 Personnel-related requirements

The AMPS shall [1] be designed such that it can be operated, maintained and sustained by 95 percent of the targeted male and female soldier population, from the appropriate

target audience, with all mission-appropriate uniform and ensemble configurations, in all environmental conditions.

The AMPS equipment shall [2] promote ease of operation and utilize controls and displays that are easy to understand and readily accessible using MIL-STD-1472 and MIL-HDBK-759 as guides. Sound Human Engineering principles shall [3] be used in system design to ensure that target audience soldiers are capable of performing required tasks with 95 percent reliability and accuracy.

The AMPS shall [4] not present any uncontrolled safety or health hazards to operators, maintainers, and support personnel during the lifecycle of the system using MIL-STD-1472 and MIL-STD-1474 as guides.

### 3.14 Training-related requirements

The AMPS shall [1] support FCS requirements for collective virtual or constructive embedded training without the engine operation.

The AMPS shall [2] be capable of powering embedded training sub-systems (including mission planning and rehearsal) without the host vehicle engine running using either external electric power (commercial or standard Army generator) provided through an externally mounted junction box or on-board AMPS power source(s).

### 3.15 Logistics-related requirements

The AMPS shall [1] support FCS requirements for transport into theater primarily using strategic, long-range aircraft, including: C-5 and C-17 aircraft and intra-theater by C-130 aircraft, rail, sea and other ground transportation vehicles.

The AMPS shall [2] also be consistent with FCS MULE requirements for deployment by CH 47 or UH-60 helicopter sling load.

### 3.16 Other requirements

None.

### 3.17 Packaging requirements

None.

### 3.18 Precedence and criticality of requirements

All the requirements of this specification have equal precedence and criticality.

# 4 QUALIFICATION PROVISIONS

## 4.1 General

This section specifies the method(s) to be used to ensure each requirement of Section 3 has been satisfied. Qualification methods include:

a) Demonstration: The operation of the system, or a part of the system, that relies on observable functional operation not requiring the use of instrumentation, special test equipment, or subsequent analysis.

b) Test: The operation of the system, or part of the system, using instrumentation or special test equipment to collect data for later analysis.

c) Analysis: The processing of accumulated data obtained from other qualification methods. Examples are reduction, interpolation, or extrapolation of test results.

d) Inspection: The visual examination of system components, documentation, etc.

A Verification Matrix, that relates Section 3 requirements to the specific qualification method(s) to be used, is shown in Table 4.1-1

Table 4.1-1 AMPS Requirements Verification Matrix

| Paragraph | Requirement | Qualification Method | | | |
|---|---|---|---|---|---|
| | | Demonstration | Test | Analysis | Inspection |
| | | | | | |
| 3 | REQUIREMENTS | | | | |
| 3.1 | Required states and modes | X | | | |
| 3.1.1 | AMPS system modes | X | | | |
| 3.1.1.1 | Combat mode | X | | | |
| 3.1.1.2 | Silent mode | X | | | |
| 3.1.1.3 | Planning mode | X | | | |
| 3.1.1.4 | Maintenance mode | X | | | |
| 3.1.1.5 | Fording mode | X | | | |
| 3.1.1.6 | Transit mode | X | | | |
| 3.1.1.7 | Cold operations mode | X | | | |
| 3.1.1.8 | Protection enhancement mode | X | | | |
| 3.1.1.9 | MOPP mode | X | | | |
| 3.1.1.10 | Sustainment mode | X | | | |
| 3.1.2 | AMPS states | X | | | |

| Paragraph | Requirement | Qualification Method | | | |
|---|---|---|---|---|---|
| | | Demonstration | Test | Analysis | Inspection |
| 3.2 | System capability requirements | | | | |
| 3.2.1 | General | | X | | |
| 3.2.2 | Power generation | | X | | |
| 3.2.2.1 | Smart alternator | | X | | |
| 3.2.2.2 | Fuel cell | | X | | |
| 3.2.2.3 | Integrated starter/alternator | | X | | |
| 3.2.3 | Energy storage | | X | | |
| 3.2.3.1 | Smart battery | | X | | |
| 3.2.3.2 | Ultra-capacitor | | X | | |
| 3.2.4 | Smart power architecture | | X | | |
| 3.2.5 | Modeling and simulation | X | | | |
| 3.2.6 | System capability relationships | | | X | |
| 3.3 | System external interface requirements | | | | |
| 3.3.1 | Interface identification and diagrams | | | X | |
| 3.3.2 | Host system integration interface | X | | | |
| 3.3.3 | Host propulsion system interface | X | | | |
| 3.3.4 | DC output power interface | X | | | |
| 3.3.5 | NATO slave interface | X | | | |
| 3.3.6 | Test and maintenance interface | X | | | |
| 3.4 | System internal interface requirements | | | X | |
| 3.5 | System internal data requirements | | | X | |
| 3.5.1 | Data logging | | | X | |
| 3.6 | Adaptation requirements | | | X | |
| 3.7 | Safety requirements | X | | | |
| 3.7.1 | Warnings, cautions and alerts | X | | | |
| 3.8 | Security and privacy requirements | X | | | |
| 3.9 | System environment requirements | | | | |
| 3.9.1 | Environmental conditions | | | X | |
| 3.9.1.1 | Natural environment | | | | |
| 3.9.1.1.1 | Temperature | | | X | |
| 3.9.1.1.2 | Humidity | | | X | |
| 3.9.1.1.3 | Altitude | | | X | |
| 3.9.1.1.4 | Salt fog | | | X | |
| 3.9.1.1.5 | Lightning | | | X | |
| 3.9.1.2 | Induced environment | | | | |
| 3.9.1.2.1 | Shock | | | X | |
| 3.9.1.2.2 | Vibration | | | X | |
| 3.9.1.2.3 | Chemical, biological, radiological and nuclear | | | X | |
| 3.9.1.2.4 | Electromagnetic environment effects | | | | |
| 3.9.1.2.4.1 | EMI/EMC | | | X | |
| 3.9.1.2.4.2 | HEMP | | | X | |

| Paragraph | Requirement | Qualification Method | | | |
|---|---|---|---|---|---|
| | | Demonstration | Test | Analysis | Inspection |
| 3.9.1.2.4.3 | Grounding, bonding and shielding | | | X | |
| 3.9.1.2.5 | Noise levels | | | X | |
| 3.10 | Computer resource requirements | | | X | |
| 3.10.1 | Computer hardware requirements | | | X | |
| 3.10.2 | Computer hardware resource utilization requirements | | | X | |
| 3.10.3 | Computer software requirements | | | X | |
| 3.10.3.1 | Reprogramming | | | X | |
| 3.10.4 | Computer communications requirements | | | X | |
| 3.11 | System quality factors | | | | |
| 3.11.1 | Reliability | | | X | |
| 3.11.2 | Maintainability | | | X | |
| 3.11.2.1 | Prognostics | | | X | |
| 3.11.2.2 | Diagnostics | | | X | |
| 3.12 | Design and construction constraints | | | | |
| 3.12.1 | Materials, parts, and processes | | | X | |
| 3.12.2 | Government property | N/A | N/A | N/A | N/A |
| 3.12.3 | Programming language | | | X | |
| 3.12.4 | Physical characteristics | | | | |
| 3.12.4.1 | Weight | | | X | |
| 3.12.4.2 | Dimensions | | | | X |
| 3.13 | Personnel-related requirements | X | | | |
| 3.14 | Training-related requirements | | | X | |
| 3.15 | Logistics-related requirements | | | X | |
| 3.16 | Other requirements | N/A | N/A | N/A | N/A |
| 3.17 | Packaging requirements | N/A | N/A | N/A | N/A |
| 3.18 | Precedence and criticality of requirements | N/A | N/A | N/A | N/A |
| | | | | | |

# 5 REQUIREMENTS TRACEABILITY

## 5.1 General

Table 5.1-1 below provides a complete list of requirements contained in this SSS as well as the traceability to the source documentation from which the requirements were derived.

Table 5.1-1 AMPS System Requirements Traceability

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
|---|---|---|---|---|---|
| | | | | | |
| | 3 | REQUIREMENTS | | | |
| | 3.1 | Required states and modes | | | |
| | 3.1.1 | AMPS system modes | | | |
| | 3.1.2 | AMPS states | | | |
| | 3.2 | System capability requirements | | | |
| 1. | 3.2.1 | General | [1] | The AMPS shall [1] provide all the electrical power and energy needs to support a particular combat vehicle's mission, including silent run, silent watch, and all the added mission packages. | FCS ORD |
| 2. | | | [2] | The AMPS system shall [2] be highly efficient, lightweight, low volume, and have a 25% added power reserve for future needs. | Derived by AMPS IPT |
| 3. | | | [3] | The AMPS [3] shall sustain the electrical requirements of digital technologies without running the host platform's engine and at the same time emit very low levels of acoustic and thermal signatures. | FCS ORD |
| 4. | | | [4] | The AMPS shall [4] be capable of providing continuous power to avoid loss of all system data during power outages. | Derived by AMPS IPT |
| 5. | | | [5] | The AMPS shall [5] be adaptable to standard worldwide commercial alternating current power (120 volts/60 hertz and 220 volts/50 hertz). | FCS ORD |
| 6. | | | [6] | AMPS equipment shall [6] meet the applicable requirements of the National Electrical Code, NFPA 70-02. | FCS MGV Common Spec |
| 7. | 3.2.2 | Power generation | [1] | Combinations of internal and external AMPS power sources shall [1] provide for host vehicle operation for a minimum of 7-days (Threshold) and a maximum of 30-days (Objective) under | FCS ORD |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
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| | | | | tactical conditions. | |
| 8. | | | [2] | Host vehicle platform Vetronics, C4ISR system and embedded training sub-systems (including mission planning and rehearsal) shall [2] be capable of operating without the engine running using either external electric power (commercial or standard Army generator) provided through an externally mounted junction box or on-board power source(s). | FCS MGV Common Spec |
| 9. | | | [3] | The AMPS shall [3] be equipped with DC (28VDC IAW MIL-STD-1275 and 42VDC IAW with ISO/WD 21848) and AC (110/220V, 50/60Hz) power generation capabilities. | Derived from Stryker ORD |
| 10. | | | [4] | For 28 VDC power generation, the AMPS shall [4] operate in accordance with the fault free and single fault characteristics specified in MIL-STD-1275. | Derived by AMPS IPT |
| 11. | | | [5] | The AMPS shall [5] be capable of transitioning between on board power sources without any loss of functionality. | FCS MGV Common Spec |
| 12. | | | [6] | The AMPS shall [6] provide for electrical isolation between any AC voltage buses and grounded DC voltage buses. | Derived by AMPS IPT |
| 13. | | | [7] | The AMPS shall [7] provide protection from voltage reversals, open circuits, short circuits, and arcing. | Derived by AMPS IPT |
| 14. | | | [8] | AMPS power sources shall [8] not generate thermal, electromagnetic, or acoustic signatures that are easily detectable from a distance greater than 10 meters. | FCS ORD |
| 15. | 3.2.2.1 | Smart alternator | [1] | The Smart Alternator shall [1] be programmable to supply optimum charging currents to Ultra-capacitors, Fuel Cell Electrolyzers, and several different technologies of batteries. | Derived by AMPS IPT |
| 16. | | | [2] | The Smart Alternator shall [2] provide a temperature compensated charging capability. | Derived by AMPS IPT |
| 17. | | | [3] | The Smart Alternator shall [3] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. | Derived by AMPS IPT |
| 18. | | | [4] | The Smart Alternator shall [4] be capable of supplying 14, 28, and 42 volt electrical power. | Derived by AMPS IPT |
| 19. | 3.2.2.2 | Fuel cell | [1] | The Vehicle Integrated Multi-service Regenerative Electrolyzer Fuel cell (VI-MREF) base concept system shall | Derived by AMPS IPT |

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| | | | | [1] weigh no greater than 140 kg. | |
| 20. | | | [2] | The VI-MREF shall [2] be designed to physically fit into a standard 130L battery compartment. | Derived by AMPS IPT |
| 21. | | | [3] | The VI-MREF shall [3] be capable of delivering up to 6 kW of instantaneous (cranking) power. | Derived by AMPS IPT |
| 22. | | | [4] | The VI-MREF shall [4] deliver 6 to 20 hours of operation within the range of high function (2 kW) down to minimum (800 W) power conditions. | Derived by AMPS IPT |
| 23. | | | [5] | Additional space of a second 130L battery compartment shall [5] allow the VI-MREF to support 12 to 40 hours of operation. | Derived by AMPS IPT |
| 24. | | | [6] | The VI-MREF shall [6] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. | Derived by AMPS IPT |
| 25. | 3.2.2.3 | Integrated starter/alternator | [1] | The Integrated Starter/Alternator (ISA) shall [1] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. | Derived by AMPS IPT |
| 26. | 3.2.3 | Energy storage | [1] | Combinations of internal and external AMPS energy sources shall [1] provide for host vehicle operation for a minimum of 7-days (Threshold) and a maximum of 30-days (Objective) under tactical conditions. | FCS ORD |
| 27. | | | [2] | AMPS on-board energy sources shall [2] be rechargeable and replaceable | FCS ORD |
| 28. | | | [3] | The AMPS shall [3] support a host vehicle silent watch mode allowing operation of electrically powered ISR/TA payloads and other mission critical C4ISR capabilities without running the platform engine (minimum thermal and acoustic signature emissions) for a minimum of 8 hours (Threshold) and a maximum of 12 hours (Objective). | FCS ORD<br>MULE PCD |
| 29. | | | [4] | The AMPS shall [4] be capable of performing battery recharging in support of both mounted and dismounted infantry squads. | Derived from FCS ORD |
| 30. | | | [5] | The AMPS shall [5] enable an 80% increase in energy storage density and twice the normal life of current US Army standard batteries. | Derived by AMPS IPT |
| 31. | | | [6] | AMPS energy storage devices shall [6] not generate thermal, electromagnetic, or acoustic signatures that are easily detectable from a distance greater than 10 meters. | FCS ORD |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
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| 32. | 3.2.3.1 | Smart battery | [1] | The Smart Battery shall [1] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. | Derived by AMPS IPT |
| 33. | | | [2] | At a minimum, the Smart Battery status shall [2] include the following parameters:<br><br>• State of Charge<br>• State of Health<br>• Run Time Until Empty<br>• Run Time to Start<br>• Run Time Till Full<br>• Battery Voltage<br>• Battery Current<br>• Battery Temperature | Derived by AMPS IPT |
| 34. | 3.2.3.2 | Ultra-capacitor | [1] | The Ultra-Capacitor shall [1] boost cold starting capability of a diesel engine vehicle at a temperature of –25 F degrees. | Derived by AMPS IPT |
| 35. | | | [2] | The Ultra-Capacitor shall [2] provide status to the AMPS "Smart" power architecture through an ISO 11898 Controller Area Network (CAN) interface. | Derived by AMPS IPT |
| 36. | 3.2.4 | Smart power architecture | [1] | The AMPS shall [1] include a "Smart" power architecture that is capable of providing uninterrupted power required to operate the mission critical equipment of the host vehicle. | Derived by AMPS IPT |
| 37. | | | [2] | The AMPS shall [2] manage electrical power distribution and utilization and monitor and protect power system and loads. | Derived by AMPS IPT |
| 38. | | | [3] | The AMPS shall [3] be capable of controlling and monitoring Remote Power Controllers (RPCs). | Derived by AMPS IPT |
| 39. | | | [4] | The AMPS shall [4] include power sensing and stored energy management. | Derived by AMPS IPT |
| 40. | | | [5] | The AMPS shall [5] be capable of dynamic load prioritization and shedding load selection. | Derived by AMPS IPT |
| 41. | | | [6] | The AMPS shall [6] provide host vehicle electrical system status information to the crew and maintenance personnel. | Derived by AMPS IPT |
| 42. | | | [7] | The status information shall [7] include electrical faults or problems, battery charge, battery life remaining at present load, battery pack health, alternator health, and alternator current output. | Derived by AMPS IPT |
| 43. | | | [8] | The AMPS shall [8] contain a standard NATO electrical slave receptacle. | Derived by AMPS IPT |
| 44. | | | [9] | The NATO slave receptacle shall [9] support: | Derived by AMPS IPT |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
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| | | | | • Re-charging of all AMPS/host vehicle batteries<br>• Powering the host vehicle with an external power source<br>• "Slave" starting the host vehicle<br>• Powering standard tools and diagnostic equipment | |
| 45. | 3.2.5 | Modeling and simulation | [1] | The AMPS STO shall [1] develop a ground vehicle electrical system modeling and simulation tool. | Derived by AMPS IPT |
| 46. | | | [2] | The modeling and simulation tool shall [2] be capable of:<br><br>• Providing highly accurate estimates of vehicle power consumption<br>• Determining the power required for various mission scenarios<br>• Calculating silent watch durations for a given subset of vehicle equipment<br>• Providing a simulation capability to determine minimum/average/typical/peak power consumption<br>• Considering vehicle environmental conditions (temperature, humidity, shock, vibration, etc.) on both the power generating equipment and energy storage devices<br>• Considering automotive constraints (engine RPM, engine and/or APU fuel consumption, etc.)<br>• Analyzing vehicle degraded modes of operation (e.g. what happens if APU fails?)<br>• Exporting results to MS Office applications (Excel, PowerPoint, etc.)<br>• Performing transient simulations of voltages and currents at the power system component level | Derived by AMPS IPT |
| 47. | | | [3] | The modeling and simulation tool shall [3] accept the following as inputs:<br><br>• Vehicle electrical load parameters (minimum/average/typical/peak) for each LRU in the vehicle (include a database of standard Army equipment)<br>• Vehicle Battery characteristics and parameters<br>• Vehicle Alternator characteristics | Derived by AMPS IPT |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
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| | | | | and parameters<br>• Vehicle APU characteristics and parameters (if present)<br>• Vehicle Inverter characteristics and parameters (if present)<br>• Vehicle automotive characteristics (engine RPM, fuel capacity, etc.)<br>• Vehicle operating temperature range<br>• Power capacity requirements for reserve and growth | |
| 48. | | | [4] | The modeling and simulation tool shall [4] provide the following as outputs:<br>• Minimum/Average/Typical/Peak vehicle power consumption<br>• Minimum/Average/Typical/Peak vehicle power reserve<br>• Estimated silent watch duration<br>• Estimated average battery life (size the battery bank for the amount of Amp-Hours required based on specific requirements)<br>• APU and Generator capacity required plus the reserve capacity for future growth | Derived by AMPS IPT |
| | 3.2.6 | System capability relationships | | | |
| | 3.3 | System external interface requirements | | | |
| | 3.3.1 | Interface identification and diagrams | | | |
| 49. | 3.3.2 | Host system integration interface | [1] | The Host System Integration interface shall [1] provided a command/status type interface to facilitate the integration of AMPS into the host vehicle platform. | Derived by AMPS IPT |
| 50. | | | [2] | The AMPS "Smart" Power Architecture shall [2] accessible through this interface. | Derived by AMPS IPT |
| 51. | 3.3.3 | Host propulsion system interface | [1] | The Host Propulsion System interface shall [1] provide the mechanical power required by AMPS power generation and energy storage components. | Derived by AMPS IPT |
| 52. | 3.3.4 | DC output power interface | [1] | The DC Output Power interface shall [1] supply the 14, 28 and 42 VDC power required by the host vehicle platform. | Derived by AMPS IPT |
| 53. | | | [2] | The DC power provided by this interface shall [2] be managed by the AMPS "Smart" Power Architecture. | Derived by AMPS IPT |
| 54. | 3.3.5 | NATO slave interface | [1] | The AMPS shall [1] be equipped with a standard NATO slave interface. | Derived by AMPS IPT |
| 55. | | | [2] | At a minimum the NATO slave interface shall [2] support: | Derived by AMPS IPT |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
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| | | | | • Re-charging of all AMPS/host vehicle batteries<br>• Powering the host vehicle with an external power source<br>• "Slave" starting the host vehicle<br>• Powering standard tools and diagnostic equipment | |
| 56. | 3.3.6 | Test and maintenance interface | [1] | The AMPS shall [1] provide a Test and Maintenance (T&M) interface. | Derived by AMPS IPT |
| 57. | | | [2] | At a minimum, the T&M interface shall [2] support:<br>• Fault isolation and repair<br>• Software downloading<br>• Data logging | Derived by AMPS IPT |
| 58. | 3.4 | System internal interface requirements | [1] | System internal interface requirements for the AMPS shall [1] comply with the applicable portions of the Joint Technical Architecture-Army (JTA-Army) and the Vetronics Reference Architecture (VRA). | Derived by AMPS IPT |
| 59. | 3.5 | System internal data requirements | [1] | System internal data requirements for the AMPS shall [1] comply with the applicable portions of the Joint Technical Architecture-Army (JTA - Army) and the Vetronics Reference Architecture (VRA). | Derived by AMPS IPT |
| 60. | 3.5.1 | Data logging | [1] | The AMPS shall [1] provide a data logging capability to gather and archive internal operational and maintenance (sustainment) data. | Derived by AMPS IPT |
| 61. | | | [2] | The logged data shall [2] be accessible through the AMPS test and maintenance interface. | Derived by AMPS IPT |
| | 3.6 | Adaptation requirements | | | |
| 62. | 3.7 | Safety requirements | [1] | The AMPS shall [1] not have any uncontrolled safety or health hazards (including noise, excessive heat, and toxic fumes) that may adversely impact upon the health or safety of the operator, maintainer, trainer, or handler. | Derived by AMPS IPT |
| 63. | | | [2] | Priority shall [2] be given to eliminating or reducing, to an acceptable level of risk, hazards through design considerations with the use of Warnings, Cautions, and Alerts (WCAs) as a last resort. | Derived by AMPS IPT |
| 64. | | | [3] | Emergency controls shall [3] be easily identifiable. | Derived by AMPS IPT |
| 65. | | | [4] | Emergency controls shall [4] provide clear indication of the appropriate action required in the event of an emergency. | Derived by AMPS IPT |
| 66. | | | [5] | MIL-STD-882 shall [5] be used as a guide. | Derived by AMPS IPT |
| 67. | 3.7.1 | Warning, cautions and alerts | [1] | The AMPS shall [1] have the capability | Derived by AMPS |

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| | | | | to automatically generate Warnings, Cautions, and Alerts (WCAs) when conditions warrant. | IPT |
| 68. | | | [2] | WCAs shall [2] be defined as follows:<br>• Warnings – a condition that could result in death or injury to personnel<br>• Cautions – a condition that could result in damage to the equipment<br>• Alerts – a condition that the vehicle crew should be made aware | Derived by AMPS IPT |
| 69. | | | [3] | Warnings shall [3] take priority over Cautions and Alerts. | Derived by AMPS IPT |
| 70. | | | [4] | Cautions shall [4] take priority over Alerts. | Derived by AMPS IPT |
| 71. | | | [5] | WCAs shall [5] be capable of generating audible and/or visual alarms. | Derived by AMPS IPT |
| 72. | | | [6] | The current status of all WCAs shall [6] be included in the AMPS data log. | Derived by AMPS IPT |
| 73. | 3.8 | Security and privacy requirements | [1] | The AMPS shall [1] have a zeroize function capable of the permanent erasure of all sensitive digitally stored information. | Derived by AMPS IPT |
| | 3.9 | System environment requirements | | | |
| 74. | 3.9.1 | Environmental conditions | [1] | The AMPS and associated subsystems shall [1] have ruggedized features that protect against environmental vulnerabilities during host platform movement at all speeds over all terrain. | Derived by AMPS IPT |
| 75. | | | [2] | The AMPS shall [2] operate in conditions including, but not limited to, snow, moderate ice, rain, sand, dust, salt water spray and when exposed to battlefield contaminants. | Derived by AMPS IPT |
| 76. | | | [3] | The AMPS shall [3] meet or exceed specified safety and performance requirements after exposure to natural and induced environments described below. | Derived by AMPS IPT |
| | 3.9.1.1 | Natural environment | | | |
| 77. | 3.9.1.1.1 | Temperature | [1] | The AMPS shall [1] operate in ambient temperatures ranging from -35 to +140 degrees Fahrenheit (-37 to +60 degrees Centigrade). | Derived by AMPS IPT |
| 78. | | | [2] | The AMPS shall [2] survive extended storage periods in ambient temperatures ranging from –50 to +160 degrees Fahrenheit (-46 to +71 degrees Centigrade). | Derived by AMPS IPT |
| 79. | 3.9.1.1.2 | Humidity | [1] | The AMPS shall [1] be capable of operation and storage while being exposed to 0 to 100% relative humidity. | Derived by AMPS IPT |
| 80. | 3.9.1.1.3 | Altitude | [1] | The AMPS shall [1] be capable of | Derived by AMPS |

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| | | | | withstanding, without preparation or any degradation in performance, the altitude requirements of MIL-STD-810. | IPT |
| 81. | | | [2] | The AMPS shall [2] be capable of storage and operation at "cabin" altitudes up to 15,000 feet or 8.3 psia as per MIL-STD-810. | Derived by AMPS IPT |
| 82. | 3.9.1.1.4 | Salt fog | [1] | The AMPS shall [1] operate without performance degradation during and after exposure to a salt fog concentration of 5±1 percent for 48 hours as per MIL-STD-810. | Derived by AMPS IPT |
| 83. | 3.9.1.1.5 | Lightning | [1] | The AMPS shall [1] remain operational after a lightening strike without adverse impact to the vehicle or crew. | Derived by AMPS IPT |
| | 3.9.1.2 | Induced environment | | | |
| 84. | 3.9.1.2.1 | Shock | [1] | The AMPS shall [1] be capable of withstanding high levels of induced shock encountered during various modes of operation and transport including traversing difficult cross country terrain, and transport on fixed wing aircraft. | Derived by AMPS IPT |
| 85. | | | [2] | The AMPS shall [2] withstand the rail impact test specified in MIL-STD-810 without degradation or damage. | Derived by AMPS IPT |
| 86. | 3.9.1.2.2 | Vibration | [1] | The AMPS shall [1] operate without performance degradation or damage from the effects of vibration during the conduct of a mission or during transport. | Derived by AMPS IPT |
| 87. | 3.9.1.2.3 | Chemical, biological, radiological and nuclear | [1] | The AMPS shall [1] be hardened against the material damaging effects of Chemical, Biological, Radiological, and Nuclear (CBRN) and chemical/toxic industrial material contaminants and decontaminants. | Derived by AMPS IPT |
| 88. | | | [2] | The AMPS shall [2] survive initial nuclear radiation (INR), blast, thermal effects such that all essential mission functions are operational within the host vehicle initialization times. | Derived by AMPS IPT |
| | 3.9.1.2.4 | Electromagnetic environment effects | | | |
| 89. | 3.9.1.2.4.1 | EMI/EMC | [1] | The AMPS shall [1] be Electromagnetic Compatible (EMC) and must not cause disruptive EMI (per MIL-STD-461, MIL-STD-462 and MIL-STD-464) nor post a hazard to any existing or proposed ordnance system. | Derived by AMPS IPT |
| 90. | 3.9.1.2.4.2 | HEMP | [1] | The AMPS shall [1] be able to support critical mission functions of the host vehicle while in NBC contaminated environments and within 15 minutes following High-altitude Electromagnetic Pulse Environments | Stryker Performance Spec |

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| | | | | (HEMP). | |
| 91. | 3.9.1.2.4.3 | Grounding, bonding and shielding | [1] | AMPS electrical and electronic equipment enclosures shall [1] be grounded to the vehicle structure. | Derived by AMPS IPT |
| 92. | | | [2] | Electrical harnesses shall [2] contain an overall shield bonded to the backshell of each harness connector. | Derived by AMPS IPT |
| 93. | | | [3] | All design components that include sensitive electronics elements shall [3] include appropriate enclosures, bonding and grounding to protect them from Electro-Static Discharge (ESD) from human contact. | Derived by AMPS IPT |
| 94. | | | [4] | The AMPS shall adhere [4] to the system grounding guidelines contained in the VRA. | Derived by AMPS IPT |
| 95. | 3.9.1.2.5 | Noise levels | [1] | Maximum noise levels for the AMPS shall [1] be within the guidelines specified by MIL-STD-1474. | Derived by AMPS IPT |
| 96. | 3.10 | Computer resource requirements | [1] | The AMPS system design approach shall [1] comply with the applicable portions of the Joint Technical Architecture - Army (JTA - Army). | Derived by AMPS IPT |
| 97. | | | [2] | Any proposed technical designs that deviate from the standards and practices delineated in the JTA - Army shall [2] be approved by the Army Digitization Office (ADO) prior to implementation. | Derived by AMPS IPT |
| 98. | | | [3] | The AMPS System Architecture shall [3] also comply with the applicable recommendations of the Vetronics Reference Architecture (VRA) and the Joint Architecture for Unmanned Systems (JAUS). | Derived by AMPS IPT |
| 99. | 3.10.1 | Computer hardware requirements | [1] | Computer hardware for the AMPS shall [1] comply with the applicable portions of the JTA-Army and the Vetronics Reference Architecture (VRA). | Derived by AMPS IPT |
| 100 | 3.10.2 | Computer hardware resource utilization requirements | [1] | At the time of AMPS delivery, processor and memory utilization (calculated as total capacity used divided by total capacity available) shall [1] be 75% or less. | Derived by AMPS IPT |
| 101 | 3.10.3 | Computer software requirements | [1] | Computer software for the AMPS shall [1] comply with the applicable portions of the JTA-Army and the VRA. | Derived by AMPS IPT |
| 102 | | | [2] | Functional application computer software developed shall [2] use a DoD approved software programming language unless appropriate waivers are obtained. | Derived by AMPS IPT |
| 103 | | | [3] | Computer software developed or provided shall [3] be consistent with the Real Time Operating Environment specified in Boeing Document S786-51.210, "Real Time Common | Derived by AMPS IPT |

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| | | | | Operating Environment Software Requirement Specification". | |
| 104 | 3.10.3.1 | Reprogramming | [1] | The AMPS shall [1] have the capability to reprogram onboard software from an external device (e.g. Laptop Computer, Software Loader/Verifier (SL/V), Mission Data Loader (MDL), etc.). | Derived by AMPS IPT |
| 105 | | | [2] | Reprogramming shall [2] provide the capability to program all devices with AMPS developed software. | Derived by AMPS IPT |
| 106 | | | [3] | Each device with AMPS developed software shall [3] provide the reprogramming device, the currently loaded:<br>• Software module name<br>• Version number<br>• Date of last download | Derived by AMPS IPT |
| 107 | 3.10.4 | Computer communications requirements | [1] | Computer communications for the AMPS shall [1] comply with the applicable portions of the JTA-Army and the VRA. | Derived by AMPS IPT |
| 108 | | | [2] | AMPS computer communications shall [2] be commercial standards based, modular in design, and scalable to meet new requirements. | Derived by AMPS IPT |
| | 3.11 | System quality factors | | | |
| 109 | 3.11.1 | Reliability | [1] | The reliability of the AMPS shall [1] be consistent with the FCS host vehicle requirement for an Operational Readiness Rate of 95% (Threshold) and 99% (Objective). | FCS ORD |
| 110 | | | [2] | In addition, the reliability of the AMPS shall [2] be consistent with the FCS host vehicle requirements for:<br>• Mean Time Between System Abort (MTBSA) or failures that deadline the host platform, result in unsafe operation, or make it non-mission capable. The FCS MULE has an MTBSA requirement of 1148 hours minimum.<br>• Mean Time Between Essential Function Failure (MTBEFF) or failures that results in host system degradation. The FCS MULE has an MTBEFF of 287 hours minimum.<br>• Mean Time Between System Abort –Mobility (MTBSA-M) or failures that affect the host platform's mobility system, | Derived by AMPS IPT |

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| | | | | resulting in unsafe operation, or making it non-combat capable. FCS MTBSA-M for a 72 hour, high OPTEMPO mission pulse must be greater than or equal to 6450 hours. | |
| 111 | 3.11.2 | Maintainability | [1] | The AMPS shall [1] be designed for ease of maintenance and repair by using Line Replacement Units (LRUs)/Line Replacement Modules (LRMs) and Shop Replacement Units (SRUs). | Derived by AMPS IPT |
| 112 | | | [2] | In addition, the maintainability of the AMPS shall [2] be consistent with the following FCS host vehicle requirements:<br>• Maintenance Ratio (MR) must not exceed 0.05 Maintenance Man Hours/Operating Hour (MMH/OH).<br>• Platform crews must be able to repair/replace at least 80% of System Aborts (SA), 80% Essential Function Failures (EFF), and 80% of Non- Essential Function Failures (NEFF) without the use of any special tools or support equipment.<br>• Mean Time To Repair (MTTR) must not exceed 0.5 hours.<br>• Each FCS system must provide the capability for automated Preventive Maintenance Checks and Services (PMCS). | Derived by AMPS IPT |
| 113 | | | [3] | The AMPS shall [3] incorporate both embedded prognostics and embedded diagnostics that detect and isolate faults to the individual LRU/LRM/SRU level. | Derived by AMPS IPT |
| 114 | | | [4] | Prognostics and diagnostics shall [4] provide the level of detection and isolation required to meet the stated reliability requirements stated in Paragraphs 3.11.1. | Derived by AMPS IPT |
| 115 | | | [5] | The use of stand-alone test equipment shall [5] be minimized. | Derived by AMPS IPT |
| 116 | | | [6] | The use of embedded prognostics and diagnostics shall [6] be maximized. | Derived by AMPS IPT |
| 117 | | | [7] | The AMPS design shall [7] minimize the number of distinct electrical connectors interfacing with internal LRUs/LRMs and the vehicle host platform. | Derived by AMPS IPT |
| 118 | | | [8] | Electrical and electronic connectors to | Derived by AMPS |

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| | | | | be used within the AMPS shall [8] be "keyed" to help ensure proper mating with the proper LRU/LRM. | IPT |
| 119 | 3.11.2.1 | Prognostics | [1] | The AMPS shall [1] incorporate an embedded prognostics capability that will predict with 0.90 probability a critical system failure (any failures causing host vehicle system or mobility aborts) to the appropriate LRU/LRM that has a 50% or higher chance of occurrence in the succeeding 96 hours. | Derived by AMPS IPT |
| 120 | 3.11.2.2 | Diagnostics | [1] | The AMPS shall [1] incorporate embedded diagnostics that can detect 99% of all detectable failures/faults with no more than 5% error rate (false alarm or missed failures/faults). | Derived by AMPS IPT |
| 121 | | | [2] | The diagnostics shall [2] be able to isolate:<br>• To one LRU/LRM 95%, ambiguity group of 1<br>• To two or less LRUs/LRMs 97%, ambiguity group of 2<br>• To three or less LRUs/LRMs 99 %, ambiguity group of 3 | Derived by AMPS IPT |
| | 3.12 | Design and construction constraints | | | |
| 122 | 3.12.1 | Materials, parts and processes | [1] | No radioactive or asbestos materials shall [1] be used in the manufacture or assembly of the AMPS such that any part of any component of the AMPS retains any of these materials, excluding GFE. | Derived by AMPS IPT |
| 123 | | | [2] | No ozone-depleting substances shall [2] be used in the manufacture, assembly, or are required for the sustainment of the AMPS. | Derived by AMPS IPT |
| | 3.12.2 | Government property | | | |
| 124 | 3.12.3 | Programming language | [1] | AMPS computer software programming language usage shall [1] comply with the applicable portions of the JTA-Army and the VRA. | Derived by AMPS IPT |
| | 3.12.4 | Physical characteristics | | | |
| 125 | 3.12.4.1 | Weight | [1] | The weight of the AMPS shall [1] be consistent with the weight constraints of the host vehicle including transport by C-130 (cannot exceed 32,000 pounds total weight, axle load of 13,000 pounds, or a tire pressure of 100 pounds per square inch) (3 to 9 MULE platforms per C-130), CH-47 (1 to 3 MULE platforms per CH-47), and UH-60 (gross vehicle weight of 5,000 pounds maximum) (one MULE | Derived by AMPS IPT |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
|---|---|---|---|---|---|
| | | | | platform per UH-60). | |
| 126 | 3.12.4.2 | Dimensions | [1] | The physical dimensions of the AMPS shall [1] be consistent with the available mounting space for power generation and distribution components within the host vehicle. | Derived by AMPS IPT |
| 127 | 3.13 | Personnel-related requirements | [1] | The AMPS shall [1] be designed such that it can be operated, maintained and sustained by 95 percent of the targeted male and female soldier population, from the appropriate target audience, with all mission-appropriate uniform and ensemble configurations, in all environmental conditions. | Derived by AMPS IPT |
| 128 | | | [2] | The AMPS equipment shall [2] promote ease of operation and utilize controls and displays that are easy to understand and readily accessible using MIL-STD-1472 and MIL-HDBK-759 as guides. | Derived by AMPS IPT |
| 129 | | | [3] | Sound Human Engineering principles shall [3] be used in system design to ensure that target audience soldiers are capable of performing required tasks with 95 percent reliability and accuracy. | Derived by AMPS IPT |
| 130 | | | [4] | The AMPS shall [4] not present any uncontrolled safety or health hazards to operators, maintainers, and support personnel during the lifecycle of the system using MIL-STD-1472 and MIL-STD-1474 as guides. | Derived by AMPS IPT |
| 131 | 3.14 | Training-related requirements | [1] | The AMPS shall [1] support FCS requirements for collective virtual or constructive embedded training without the engine operation. | Derived by AMPS IPT |
| 132 | | | [2] | The AMPS shall [2] be capable of powering embedded training sub-systems (including mission planning and rehearsal) without the host vehicle engine running using either external electric power (commercial or standard Army generator) provided through an externally mounted junction box or on-board AMPS power source(s). | Derived by AMPS IPT |
| 133 | 3.15 | Logistics-related requirements | [1] | The AMPS shall [1] support FCS requirements for transport into theater primarily using strategic, long-range aircraft, including: C-5 and C-17 aircraft and intra-theater by C-130 aircraft, rail, sea and other ground transportation vehicles. | Derived by AMPS IPT |
| 134 | | | [2] | The AMPS shall [2] also be consistent with FCS MULE requirements for deployment by CH 47 or UH-60 helicopter sling load. | Derived by AMPS IPT |

| Req't # | Paragraph | Paragraph Title | Req't ID | Requirement Text | Source Document |
|---|---|---|---|---|---|
| | 3.16 | Other requirements | | | |
| | 3.17 | Packaging requirements | | | |
| | 3.18 | Precedence and criticality of requirements | | | |
| | | | | | |

# 6 NOTES

## 6.1 Acronyms and abbreviations

| | |
|---|---|
| AC | Alternating Current |
| ADO | Army Digitization Office |
| AMPS | Advanced Mobile integrated Power System |
| APU | Auxiliary Power Unit |
| BIT | Built-In Test |
| BITE | Built-In Test Equipment |
| C4ISR | Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance |
| CAN | Controller Area Network |
| CBRN | Chemical, Biological, Radiological, and Nuclear |
| COE | Operating Environment |
| COP | Common Operating Picture |
| DC | Direct Current |
| DID | Data Item Description |
| DoD | Department of Defense |
| EA | Electronic Architecture |
| EFF | Essential Function Failures |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| EMPRS | En-route Mission Planning and Rehearsal System |
| ESD | Electro-Static Discharge |
| FCS | Future Combat Systems |
| GDLS | General Dynamics Land Systems |
| GFE | Government Furnished Equipment |
| HDBK | Handbook |
| HEMP | High-altitude Electromagnetic Pulse |
| IAW | In Accordance With |
| INR | Initial Nuclear Radiation |
| IPT | Integrated Product Team |
| ISA | Integrated Starter/Alternator |
| ISO | International Standards Organization |
| JAUS | Joint Architecture for Unmanned Systems |
| JTA | Joint Technical Architecture |
| LDSS | Logistics Decision Support System |

| | |
|---|---|
| LRM | Line Replacement Module |
| LRU | Line Replacement Unit |
| MDL | Mission Data Loader |
| MGV | Manned Ground Vehicle |
| MIL | Military |
| MMH | Maintenance Mean Hours |
| MOPP | Mission Oriented Protective Posture |
| MR | Maintenance Ratio |
| MTBEFF | Mean Time Between Essential Function Failure |
| MTBSA | Mean Time Between System Abort |
| MTBSA-M | Mean Time Between System Abort –Mobility |
| MTTR | Mean Time To Repair |
| MULE | Multifunction Utility/Logistics and Equipment |
| N/A | Not Applicable |
| NAC | National Automotive Center |
| NATO | North Atlantic Treaty Organization |
| NBC | Nuclear, Biological and Chemical |
| NEFF | Non- Essential Function Failures |
| OH | Operating Hour |
| ORD | Operational Requirements Document |
| PCD | Procurement Control Document |
| PMCS | Preventive Maintenance Checks and Services |
| PS-MRS | Platform Soldier-Mission Readiness System |
| RPC | Remote Power Controller |
| RPM | Revolutions Per Minute |
| SBCT | Stryker Brigade Combat Team |
| SL/V | Software Loader/Verifier |
| SRU | Shop Replacement Unit |
| SSS | System/Subsystem Specification |
| STD | Standard |
| STO | Science and Technology Objective |
| SW | Software |
| T&M | Test and Maintenance |
| TARDEC | TACOM Research Development and Engineering Center |
| TBD | To Be Determined |
| UGV | Unmanned Ground Vehicle |
| V | Volts |
| VAC | Volts Alternating Current |
| VDC | Volts Direct Current |
| Vetronics | Vehicle Electronics |

| | |
|---|---|
| VI-MREF | Vehicle Integrated - Multi-service Regenerative Electrolyzer Fuel cell |
| VRA | Vetronics Reference Architecture |
| W | Watts |
| WCA | Warnings, Cautions, and Alerts |

# 7 APPENDIX A – FUTURE REQUIREMENTS

## 7.1 General

Table 7.1-1 below identifies future requirements for the AMPS. As the AMPS program evolves and matures, future requirements may be moved into Section 3 (Requirements).

Table 7.1-1 AMPS Future Requirements

| Req't # | Requirement Text | Notes |
|---|---|---|
| | | |
| 1. | TBD | TBD |
| 2. | TBD | TBD |
| 3. | TBD | TBD |
| | | |