Kuwait – 2007

87,000 batteries
Afghanistan – September 2011
Cold Cranking Amps or CCA represents the amount of power a new (fully charged) battery can deliver for 30 seconds at 0 degrees Fahrenheit before the voltage falls to 7.20 V (six cells).

Cranking Amps or CA represents the amount of power a new (fully charged) battery can deliver for 30 seconds at 32 degrees Fahrenheit before the voltage falls to 7.20 V (six cells). This rating can also be referred to as Marine Cranking Amps (MCA).

Reserve Capacity or RC is a very important rating. This is the number of minutes a fully charged battery at 80 ° F will discharge 25 amps until the battery drops below 10.5 volts.

Amp hour or AH is a rating usually found on deep cycle batteries. If a battery is rated at 100 amp hours it should deliver 5 amps for 20 hours, 20 amps for 5 hours, etc.

Japanese industrial standards or JIS is a battery rating option on some conductance testers which will test a battery to a Japanese battery rating standard.

Deutsches Institut für Normung or DIN is a battery rating option on some conductance testers which will test a battery to a German battery rating standard.
Conventional Battery Design

NSN 6140-01-446-9498
6TMF/TYPEI (Dry with over-packed electrolyte)

NSN 6140-01-446-9506
6TMF/TYPEII (for consignment)
(+ and (-) plates are connected to make a 2 volt cell.

All 6 cells are connected inside the box to make a 12 volt battery. The case is filled with electrolyte (sulfuric acid & water). Electrolyte must always cover the battery plates (but don’t fill to top).
6TL, 6TLFP, 6TMF, and other commercially available batteries

All of these batteries are flooded (“wet”) cell lead acid batteries. Though they appear similar they have different chemistry, capacities and voltages.

6TMF

The current battery provided by military supply.

Brown case with a black top.

It is also a lead calcium plate chemistry.

Built-in hydrometer (a green eye).

Note: The green eye only allows you to look at one cell in the battery and as such is not a reliable indication of overall battery condition. That is why the “eye” can indicate a battery is good but it still doesn’t perform properly.
Conventional Battery Design

6 TLFP

- Black top and lead calcium chemistry plates.
- Produced and shipped as a Dry battery with an acid over-pack.
  > Must be filled by unit
  > Must be charged prior to installation / use
  > Acid Over-pack is a shipment hazard.

Conventional style generator batteries in use by the US Military:

4HN, 2HN

- Use lead antimony plates, many are still in the government system.
- Vary in size and voltage.
- 2HN, 12 volt. Used in small generators, i.e. the 5kW
- 4HN battery is a 24-volt battery (cannot be recovered in current military battery shops due to the lack of a 24-volt charger).
Conventional Battery Design

4HN Wet NSN: 6140-01-390-1968

2HN Wet NSN: 6140-01-390-1969
6TAGM Battery Design

Example: HAWKER 6TAGM Battery
NSN 6140-01-485-1472  P/N 9750N7025
Example: EXIDE 6TAGM Battery
NSN 6140-01-485-1472  P/N 6TL100G0A
6TAGM Battery Design

Example: BATCORE 6TAGM Battery
NSN 6140-15-180-0587  P/N FAMX12120
Example: Exide Group 31 BFV AGM Battery
NSN 6140-01-582-5710  P/N 31A925XLW
AGM Battery Design

- **Spiralcell Technology** for superior vibration resistance and extended life
- **Solid Cast Cell Connections** for increased durability and maximum plate height
- **Tightly Compressed Cells** for added vibration resistance
- **99.99% Pure Lead**
  Spiralcell design allows for lead to be used in its purest form
- **Absorbent Glass-Mat Separators**
  Holds electrolyte like a sponge to eliminate acid spilling

Example: Optima AGM authorized 2HN Replacement
NSN 6140-01-529-7226
Example: Optima AGM Spiral Core Battery
Battery NSN: 6140-01-374-2243
6T Adapter Plate NSN: 6160-01-453-0858
Concorde AGM Battery – 4HN replacement in some platforms.

Example: Concorde AGM (24VDC) 4HN replacement Battery
6140-01-476-8945
Advantages of AGM batteries:

- **Longer life**
- **Less maintenance**
- **Safer**
  - No leaking acid
  - Eliminates corrosion to terminals & battery trays
  - No holes in your clothes, or burning skin
  - Reduced chance of battery explosion
  - Battery won’t leak or spill even if tipped over or accidentally cracked.
- **Battery will work temporarily after cracked open or taking a round**
- **Lower internal resistance**
  - Higher cranking power
  - More usable reserve capacity
  - Faster recharge
Same basic design as conventional battery, except:

- AGM batteries use an Absorbent Glass Mat to contain all the electrolyte.
  - The AGM holds all the electrolyte like a “super sponge.”
- Contains a one-way safety valve to prevent out-gassing & loss of liquid during normal operation.
- High purity lead (not recycled) plus a little tin.
- Plates are compressed into cell partition, which:
  - Prevents plate to plate movement & shorting
  - Prevents loss of active paste material
  - Increases vibration resistance
- 6TAGM Hawker battery does have the potential to freeze:
  - Fully charged = -94F or -70C
  - Fully Discharged = -4F or -20C
  - Extremely Over-discharged (>6Vdc) = 14F or -10C
A little voltage means a lot!

Only .7 volt difference

12.9 OCV

Full charge

12.2 OCV

½ charged

AGM state of charge versus OCV
Preventive Maintenance is intended to PREVENT or MITIGATE premature battery failure, reduce cost associated with man-hours (removing/charging/etc.), transportation, and purchase of new batteries.

The key to any Maintenance Program is a good Preventive Maintenance (PM) and Service Program. Test and service the batteries in the platform in conjunction with other scheduled maintenance services.

PMCS also includes checking and charging batteries prior to installation. It is very common to get “new” batteries that have been sitting idle for months prior to your receiving them. Start with a fully charged battery to ensure the battery’s life.
Ignored batteries will soon be right back to their start point.

PM is an action to prevent a problem from occurring or reoccurring.

Some PM actions are easy and cost nothing but time; others take more work and have a dollar value assigned to them.

During PMCS, batteries will often be found to be dead or in a low state of charge (this is where the ongoing Maintenance cycle is most evident).
Common Causes of Battery Failure

A battery is like a piggy bank. If you take out more than you put in, soon it is empty!!
Deficit charging - One of the most prevalent problems facing the military today.

- When the vehicle cannot fully charge the battery during normal operation. This results in a decline in capacity (shorter run time of electronics) and reduced battery life.

Typical causes are:

- Engine alternator voltage and/or amperage is too low
- Engine run time not long enough to recharge batteries
- High accessory loads (lights, radios, etc.)

**Solutions:**

- Install a higher amperage alternator
- Shut off accessories when possible (or leave engine running)
- Periodically use an external charger to service and re-condition the batteries
Mixing different types of batteries together

Connecting different types of batteries together in the vehicle \textit{WILL} lead to shorter battery pack life and possible overcharge or undercharge problems with individual batteries. Premature failure \textit{WILL} happen.

\textbf{Solution:}

- Only connect together batteries of identical make and model.
- \textbf{NEVER} mix different battery types.
Leaving batteries in a discharged condition; even a partial discharge, will cause sulfation on the plates that reduces battery capacity and leads to premature battery failure.

**Do not leave batteries discharged!**  
Damage can occur in a very short period!

**Solution:**

- Check batteries before storing vehicle & recharge batteries if needed.
- If the vehicle or equipment is not used on a regular basis, periodically check the battery OCV and charge when necessary.
- Charge whenever the battery OCV is:
  - Wet/flooded: 12.5 or less
  - AGM: 12.7 or less
- When storing vehicles that have on-board electronics, use a maintenance charger such as those provided by PulseTech Products to prevent reoccurring battery discharge.
Cathode crystalline structures remaining after charging without pulsing.
Cathode after charging and high frequency voltage pulsation.
Always conduct Inspections and Diagnostics in the vehicle or platform before removing batteries. Most batteries are physically damaged during Installation, Removal and Transportation.

Not conducting the diagnostic portion of the BMMP and ensuring your batteries are in good condition as you implement your program is one of the biggest causes for a BMMP to fail.

Diagnostics are an ongoing part of any Preventive Maintenance program. It will ultimately reduce battery consumption and the money and man-hours expended on corrective maintenance or battery replacement.
Historically the three most common methods of battery testing have been:

- Digital Multi-meter
- Common Tool Room Load Tester
- Specific Gravity Tester (Duo-check)
Multi-meter – A good first glance tool to check out a battery.

Voltage and a battery’s capability to operate may have little to do with one another. This is especially true with flooded conventional batteries.

An excellent example of this is the occasional battery that won’t start a vehicle shortly after being taken off of a battery charger. When the battery is just off charge, a multi-meter will often give you a reading of over 13 volts. Yet when you try to start a vehicle or power radios, it immediately fails and the voltage drops to 12 volts or less. The battery had voltage, surface voltage, but no capacity.

**OCV readings alone on flooded batteries are not suitable for determining battery condition or capacity.**

OCV readings are more accurate with AGM batteries.

**AGM:** OCV < 12.7 (25.4 on a 24-volt battery pack) recharge immediately.

**Flooded:** OCV < 12.5 (25.0 on a 24-volt battery pack) recharge immediately.
Load Testing – One of the least effective ways to test a battery’s condition in field. Most load testers are completely ineffective to accurately test a battery.

A Battery Shop Procedure

Creates a dead short across the battery’s terminals with a gauge that indicates how the battery handles the load.

Battery **MUST** first be fully charged (both CCA’s and Volts) which makes load testing impractical anywhere, except in a battery shop.

Load test battery per the equipment’s instructions.

If tester is not automatic, set for \( \frac{1}{2} \) the battery CCA rating.

\( 6\text{TMF: 325 amp, Hawker Armasafe: 600 amp} \)

Discharge for 15 seconds.

To pass the test, the battery voltage during load must stay above 9.6 volts

**Passing batteries must be recharged again after load test.**
Load Testing

OK for battery shop. Impractical in the field.

Use of Load testers takes time and requires caution -
  • Enormous heat and mishandling can cause burns
  • Tester must be allowed to cool after every couple of batteries

It is a time-consuming process that presents some genuine training and safety issues to users.
Can identify state of charge and bad cells.

Requires that each battery cap must be opened individually and each cell must be tested individually.

Associated safety issues from exposure to battery acid are ruined uniforms, chemical burns, etc. (required equipment: goggles, gloves and apron).

Time consuming - opening and closing each cap on a 5-ton truck means that at a minimum, properly testing four batteries will take over 30 minutes per truck. At today’s manning levels, that is too many man-hours.

Specific Gravity Testers (Duo-check) works only on flooded cell batteries

• In the past, Specific Gravity Testers were considered to be the standard for testing military batteries.
CONDUCTANCE TESTING -

Excellent snapshot of a battery’s condition

Conductance testing is the fastest, most efficient way to test the battery’s health and state-of-charge without disconnecting or removing the battery.

Conductance testing is performed with one of the 490 series Diagnostic Testers or a similar device. It’s easy to use and it can test all batteries in the vehicle/generator in minutes or less.

The 490 series Diagnostic Testers can be used repeatedly without heating up, opening caps or dealing with sulfuric acid.
CONDUCTANCE TESTING -

Uses an algorithm to compare the battery’s available capacity to a known standard.

The PulseTech 490 series testers provide the operator with a digital read-out that displays:

- Cold Cranking Amps (CCA)
- Whether the battery needs to be recharged and re-tested
- *If it has a bad cell
- OCV
- State of Health of Battery

* 490PT+ does not display bad cell reading. Many batteries that have a bad cell reading on an older tester are in fact recoverable.
Diagnostics

490 PT+
Part No. 741x491
NSN: 6130 01 510 9594

MBT-1
Part No. 741x800
NSN: 6130 01 463 8499
Mission Permitting: All corrective action should be done while the batteries are mounted in the vehicle, generator or system.

Corrective maintenance is intended to reverse or correct a problem that has already occurred.

Once you have found a dead or questionable battery--

The first question that must be asked is:

“Why?”
Battery corrective maintenance must recover batteries to their rated CCA level and voltage.

If not sufficiently recovered, replace them with known good batteries!
Chargers

When possible the charger should be an automatic type as to not accidentally overcharge the battery if it’s left connected.

**AGM batteries need a high quality charger**
Voltage needs to be properly controlled

If it does NOT have an AGM or sealed battery setting and is not automatic: Voltage should be regulated between 14.25 and 14.75 volts.

**All Chargers should be built for rough treatment:**
Heavy Duty power supply
Tough clamps for good electrical connection
Pulse Chargers — Pulse Charger/World Version PLUS

• The 12V Pulse Charger, a universal power input “smart” charger, designed to recharge any 12V lead acid (AGM or flooded cell) battery.

• Single switch operation and LED light charge indicators simplify operator training.

• This “smart” charger constantly tests the battery to insure a proper charge. Once the battery is fully charged, the unit switches to Pulse Only to maintain the battery.

(Note: The Pulse Charger incorporates a safety feature that prevents it from starting its charge regimen if a battery is below approximately 1 volt. Batteries below 1 volt can seldom be recovered.)
Pulse Chargers – Pro-HD 12/24V Charger

- The Pro-HD is an auto sensing 12/24V pulse charger designed to charge any type of lead acid battery (AGM or flooded cell) using the supplied clamps or NATO connector.

- The charger will operate anywhere in the world auto sensing voltage between 110-240V and between 50-60 Hz. Smart charging with one-switch operation minimizes operator training requirements.

- The charger will not over-charge or gas a battery. It will not charge a damaged battery and will automatically detect reverse polarity.

- Recovers single 12V or single 24V batteries as well as 24V battery packs in the vehicle.

- Eliminates the need to remove batteries to service them.

Adjusts charge voltage and current to maximize battery recovery and charging. Smart technology and pulsing prevents battery gassing which allows charging with batteries installed in the vehicles.
Corrective Maintenance
Pulse Chargers – HD Pallet Charger

– The HD Pallet Charger is for use on all 12V batteries

• The Pallet Charger is a 12V, 8 amp per channel, 12-station charging unit that uses universal electrical input.

• The charger can be connected to any type or size of 12V lead acid battery (AGM or flooded cell).

• Charge stations 1-12 each operate in isolation from one another, allowing any combination of batteries to be recharged at the same time.

• One-switch operation and LED charge indicators simplify operation and minimize operator training requirements.

• Eliminates the requirement to sort batteries by type and severity of discharge that was required with bus bar charging.

• Dramatically reduces man power requirements.
Corrective Maintenance Systems

- HD Pallet Charger
  Part No. 746x820
  NSN: 6130 01 532 7711

- Redi-Pulse Pro HD
  Part No. 746x800
  NSN: 6130 01 500 3401

- Pulse Charger/World Version
  Part No. 746x725
  NSN: 6130 01 477 4703
Battery Service Equipment Set (BSES)

- 1 – HD Pallet Charger
- 1 – Redi-Pulse Pro-HD 12/24V Charger
- 1 – Redi-Pulse Pro-12
- 10 – MBT-1 Battery Testers
- 1 – 490PT Battery Analyzer

NSN 5180-01-541-9731

"Initially we didn't think it was going to be anything other than additional charging stations, but immediately we found that we could recover twice as many batteries using the technology incorporated into the BATTCAVE Chargers."

DOL – Fort Lewis
Solar Charging Systems – Battery maintenance devices used on vehicles to prevent and break up large crystal sulfates on battery plates which occur in discharged batteries.

Sulfate crystal formations slowly destroy the battery’s capacity.

Solar charge systems can be powered by either sunlight (Solar panel) or an AC receptacle.

Older model solar maintenance systems offset the 6TL’s self-discharge from 4.4% to .8% per month.

New solar charge systems maintain and/or charge battery systems.
Solar Pulse Charge Monitor System (SPCMS)
Part No. 735x687
NSN: 6130 01 558 5371

PS Magazine Article - PS681, Aug 09

Vehicle Batteries...

THE BATTERY IS DEAD AGAIN!

THAT'S IT! I'M GOING TO GET A NEW BATTERY!

DON'T TURN IN THOSE BATTERIES, JUST USE A SOLAR TRICKLE CHARGER!

Inside the "box" there's a circuit board that produces a high frequency pulse to enhance the charge current, plus a 3 LED light battery monitoring system to keep you aware of the condition of your batteries.
PM Equipment

24V Pulse Charge Monitor System
Part No. 735x643
NSN: 6130 01 497 0964

24V Pulse Solar Charger
Part No. 735x640
NSN: 6130 01 487 0035
PM-MEP Test Summary Results for Ft. Belvoir, VA:

Equipment: Four generators
(2 batteries per generator, 24 VDC)

Two generators with new Optima 800U batteries.
(one generator with solar, one without)

Two generators with new Exide 6TMF, conventional flooded lead acid battery. (one generator with solar, one without)

Two generators with PT Solar charger: 735X643
### Preventive Maintenance (PM)

#### PM-MEP Test Summary Results for Ft. Belvoir, VA:

**Data collection:**
- Ambient temperature
- Temperature inside the generator enclosure
- Battery voltage
- Calculated CCA (conductance calculation)

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<th>Category</th>
<th>Battery Type</th>
<th>21-Apr-04</th>
<th>19-Aug-04</th>
<th>7-Oct-04</th>
<th>9-Nov-04</th>
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PM Reminders

- Check batteries on a regular basis -
  - Battery connections checked and cleaned if needed
  - Battery hold-down brackets, tighten if battery is loose
  - Dirty batteries, clean if necessary
  - Conductance test, check and charge
  - Equipment with known battery problems should be checked more frequently until problem is solved

A properly administered PM program will reduce the requirement for Corrective Maintenance and create huge savings in man-hours and money
Pro 12, Part No. 746x912
NSN: 6130 01 535 2718

Number of outputs: 12
12V 750 mA dc per output
High pulsing to desulfate
Pulse frequency: 22-28 KHz

This unit is lightweight and capable of operating from any mounting position. The charge current will apply a 200 millisecond charge 25 times a minute. The system utilizes optoisolators to provide a great degree of safety and electrical isolation from the sensitive board components. The system applies the pulse-charging interval every 2.2 seconds to a given battery attached to the system.
Conclusion:
The information and maintenance practices described today will provide direct benefits in terms of:

- Increased readiness
- Lower battery-related maintenance expenses
- Reduce man-hours needed for battery maintenance
- The longest battery life possible

Any final questions?