ETA-NTP008

Revision 4
Effective December 1, 2004

Battery Charging

Prepared by

Electric Transportation Applications

Prepared by: _____ **Date:**_____
Ryan Harkins

Approved by: _____ **Date:** _____
Donald B. Karner

©2004 *Electric Transportation Applications* All Rights Reserved

TABLE OF CONTENTS

1.0 Objectives 3

2.0 Purpose 3

3.0 Documentation 3

4.0 Initial Conditions and Prerequisites 4

5.0 Charging Activities 5

5.1 Level I and Level II Charging 5

5.2 Charging Efficiencies (Daily, Weekly, Program) 7

6.0 Glossary 8

7.0 References 10

Appendices

Appendix A - Charging Log 11

Appendix B - Metrology Setup Sheet 12

©2004 *Electric Transportation Applications* All Rights Reserved

1.0 Objective

This procedure identifies the proper method for the conduct of charging the main propulsion batteries installed in an electric vehicle while it is being tested during the NEV America Performance Test Program. It shall not supersede the charging protocols of the vehicle's manufacturer, nor is it meant to supersede those specifically addressed by SAE Test Standards, nor of any regulatory agency who may have or exercise control over the covered activities.

This procedure also provides methodology for determining charging efficiency and testing NEV America Vehicle Specification requirements for out of service endurance.

2.0 Purpose

The purpose of this procedure is to provide guidance on charging traction batteries during the time the vehicle is being subjected to the NEV America Performance Test Program. This procedure shall also be used to calculate charging efficiencies during the performance of the ETA-NTP005, "Rough Road Test," as well as other procedures that support the NEV America Technical Requirements.

Different charging strategies (e.g., using both Level I and Level II interchangeably) shall not be mixed during a single test program unless the manufacturer details that as the normal method of charge operation for the end user. If Level III charging is specified, it shall be controlled by ETA-NTP013.

3.0 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with ETA-NAC004, "Review of Test Results." Storage and retention of records during and following testing activities shall be completed as described in Procedure ETA-NAC001, "Control, Close-out and Storage of Documentation."

©2004 Electric Transportation Applications All Rights Reserved

4.0 Initial Conditions and Prerequisites

4.1 Personnel conducting charging of vehicle batteries under this procedure shall be familiar with the requirements of this procedure, any applicable SAE Test Instructions, the Administrative Control Procedures, and certified by the Program Manager or Test Manager prior to commencing any charging activities.

4.2 Charging of vehicle batteries shall be in accordance with the requirements of the vehicle/battery supplier as stated in the Owner/Operators manual.

4.3 Ambient temperature should not be in excess of 120˚F at the commencement of charging, or the maximum allowed by the manufacturer, whichever is less.

4.4 All personnel conducting charging of batteries shall observe proper safety precautions at all times.

4.5 Charging rates shall not exceed the maximum recommended by the manufacturer.

4.6 Charging of on-board battery systems should normally be accomplished at using the AC Supply voltage specified by the Supplier.

4.7 Charging at 120 VAC should only be used when specifically required by the Supplier, as the time required to charge at 120V is much longer than if completed at 208V.

4.8 Level III charging shall not be used during the NEV America Test Program, unless specifically required by the Supplier, and only after the Supplier has identified this as the preferred type of charging, and has provided this information in their Technical Submittal and user manual(s).

4.9 Should it be necessary to conduct testing using different levels of charging (Level I and Level III), two independent test programs shall be conducted, with a transition period between the two charging types completed.

4.10 Record the required data for all metrology used on Appendix B.

©2004 Electric Transportation Applications All Rights Reserved

5.0 Charging Requirements

The EV America Technical Requirements require that Suppliers provide a charger which can fully recharge the main propulsion batteries from any state of discharge in less than 12 hours. It also states that the vehicle Supplier should have the battery manufacturer review and approve the charging algorithm for the main propulsion batteries. This procedure does not verify these items, but does utilize the concepts as developmental bases. The following instructions apply to the generic activity of charging. They shall not replace or supersede the requirements of any specific manufacturer. Should a conflict arise, the requirements of the Vehicle/Battery manufacturer shall take precedence.

CAUTION

Vehicles shall not be charged from any outlet except the outlet specifically designated for that vehicle.

CAUTION

Vehicles shall not be charged using Level III Chargers unless specifically provided for by the Manufacturer. If Level III charging is required, use procedure ETA-NTP013.

5.1 Level I or Level II Charging

The following steps assume the vehicle has been parked at the charging facility, and is capable of being charged from it's dedicated charging feed.

5.1.1 Verify by physical inspection that there is no damage to the battery, charger, energy meter charging system.

5.1.2 Determine and select the proper cable and connector type for the specific vehicle being charged. This shall be determined by visual inspection of the charger connector.

5.1.3 Read and record the onboard SOC indicator reading prior to commencing the charge on Appendix A.

5.1.4 If a kilowatt-hour meter or reading is available, this should also be recorded on Appendix A.

5.1.5 Select the appropriate charging station location.

5.1.6 If so equipped, open the charging station disconnect supplying the vehicle.

5.1.7 Connect the charging cable to the kilowatt-hour meter on the vehicle. Record the meter number on the charger record.

5.1.8 Connect the charging cable to the vehicle charging station.

5.1.9 Connect the charging cable to the vehicle charging station.

©2004 Electric Transportation Applications All Rights Reserved

5.1.10 If so equipped, close the charging station disconnect supplying the vehicle.

5.1.11 Read and record on Appendix A the time that charging is started.

5.1.12 If available, read and record the initial DC charging current and voltage.

5.1.13 Verify the kilowatt-hour meter or the data logger is operating.

5.1.14 When the charge has completed (as determined by the manufacturers algorithm), record the following information as appropriate:

5.1.14.1 Time
5.1.14.2 Final voltage (if available)
5.1.14.3 Final charging current (if available)
5.1.14.4 Kilowatt-hour meter reading on the vehicle.
5.1.14.5 Charging station location energy meter reading.
5.1.14.6 Vehicle SOC reading
5.1.14.7 Kilowatt-hour meter or data logger information
5.1.14.8 Vehicle odometer reading

5.1.15 If so equipped, open the charging station disconnect supplying the vehicle.

5.1.16 Disconnect the charging cable from the charging station.

5.1.17 Disconnect the charging cable from the vehicle.

5.1.18 Disconnect the kilowatt-hour meter from the vehicle charge port.

5.1.19 Remove the kilowatt-hour meter from the vehicle and store.

5.2 Charging Efficiencies

Operation of the battery charger should be observed periodically during charging operations. Any of the following conditions should be noted using a Non-Conformance Report (ETA-NAC-002 Appendix B).

- Battery charger terminates charge prematurely or “trips”
- Battery charger does not automatically terminate charge
- Battery vents or releases electrolyte
- Battery top of charge voltage decreases or increases significantly

©2004 Electric Transportation Applications All Rights Reserved

6.0 Glossary

6.1 Charging Algorithm - The circuitry/mathematical controls used by a charger to automatically control the charging profile of current versus voltage versus time during the battery charge.

6.2 Charging Station Location - As used in this procedure, refers to the specific plug-in location assigned to each specific vehicle.

6.3 Effective Date - The date, after which the procedure has been reviewed and approved, that the procedure can be utilized in the field for official testing.

6.4 Program Manager - As used in this procedure, the individual within Electric Transportation Applications responsible for oversight of the NEV America Performance Test Program. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

6.5 Shall - Items that require adherence without deviation. Shall statements identify binding requirements. A go, no-go criterion.

6.6 Should - Items that require adherence if at all possible. Should statements identify preferred conditions.

6.7 State of Charge (SOC) - For this testing, the SOC of a battery is defined as the expected residual battery capacity, expressed in amperes-hours or watt-hours or miles, as a percentage of the total available. The 100% SOC basis (available ampere-hours, kilowatt-hours or miles) is determined by the actual discharge capability of the main propulsion battery when discharged to the requirements of the Constant Speed Range Test portion of procedure ETA-NTP004, "Constant Speed Range Test."

6.8 Test Director - The individual within Electric Transportation Applications responsible for all testing activities associated with the NEV America Performance Test Program.

6.9 Test Director's Log - A daily diary kept by the Test Director, Program Manager, Test Manager or Test Engineer to document major activities and decisions that occur during the conduct of a Performance Test Evaluation Program. This log is normally a running commentary, utilizing timed and dated entries to document the day's activities. This log is edited to develop the Daily Test Log published with the final report for each vehicle.

6.10 Test Engineer - The individual(s) assigned responsibility for the conduct of any given test. [Each contractor/subcontractor should have at least one individual filling this position. If so, they shall be responsible for adhering to the requirements of this procedure.]

©2004 Electric Transportation Applications All Rights Reserved

6.0 Glossary (continued)

6.11 Test Manager - The individual within Electric Transportation Applications responsible for the implementation of the test program for any given vehicle(s) being evaluated to the requirements of the NEV America Performance Test Program. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

7.0 References

7.1 NEV America Vehicle Technical Specification
Revision 1, April 15, 2002

7.2 ETA-NAC001, Revision 2 - "Control, Close-out and Storage of Documentation."

7.3 ETA-NAC002, Revision 2 - "Control of Test Conduct."

7.4 ETA-NAC004, Revision 2 - "Review of Test Results"

7.5 ETA-NAC005, Revision 2 - "Certification and Training of Personnel Utilizing ETA Procedures."

7.6 ETA-NAC006, Revision 2 - “Vehicle Verification”

7.7 ETA-NAC007, Revision 1 - “Receipt Inspection”

7.8 ETA-NQP001, Revision 2 - “Quality Program”

7.9 ETA-NTP002, Revision 2 - “Electric Vehicle Acceleration, Gradeability and Maximum Speed Test”

7.10 ETA-NTP004, Revision 3 - “Constant Speed Range Test”

7.11 ETA-NTP005, Revision 2 - “Rough Road Course Test”

7.12 ETA-NTP006, Revision 2 - “Braking Test”

7.13 ETA-NTP007, Revision 2 - “Road Course Handling Test”

7.14 ETA-NTP010, Revision 2 - “Measurement and Evaluation of Electric Vehicle Battery Charger Performance”

7.15 ETA-NTP011, Revision 2 - “Receipt Inspection”

©2004 Electric Transportation Applications All Rights Reserved

APPENDIX-A
BATTERY CHARGING LOG
(Page 1 of __)

Charging Station No.	Vehicle:	VIN:

DATE	TIME	Connect/ Disconnect	Onboard SOC Indicator Status	Vehicle Odometer Reading	Battery Temp (°F)	kWh Meter Reading	Comments	Initials

©2004 *Electric Transportation Applications* All Rights Reserved

APPENDIX-B
Vehicle Metrology Setup Sheet
(Page 1 of 1)

VIN: _____

Instrument/Device:	Calibration Due Date:	Initials / Date:

Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)

Approved By:

(Printed Name) (Signature) (Date)

©2004 *Electric Transportation Applications* All Rights Reserved