Standard Practice for

NTPEP Evaluation of Solar Powered Portable Changeable Message Signs

NTPEP Designation: PCMS-13-01
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1. SCOPE

1.1 This standard practice covers the requirements and testing criteria for the National Transportation Product Evaluation Program (NTPEP) evaluation of solar powered portable changeable message signs. The National Transportation Product Evaluation Program (NTPEP) serves the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

1.2 The results of this program may be used for product quality verification by individual member Departments. If used for quality verification, a letter of certification from the portable changeable message sign (PCMS) manufacturer indicating testing was conducted by NTPEP that supports published values may be required by member Departments.

1.3 This standard practice may involve hazardous materials, operations, and equipment. It does not purport to address all safety problems associated with its use. It is the responsibility of the user of this standard practice to establish the appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1 2009 Manual on Uniform Traffic Control Devices (MUTCD)

3. TERMINOLOGY

3.1 Pixel - Short for picture element. A pixel can consist of one or more LED diodes. When combined with other pixels they form a character.

3.2 Matrix – A group of pixels defining a character. An example maybe a group of five pixels wide by seven pixels high.

3.3 Character - Letter, numeral, or symbol formed by a group of pixels, usually an array of five-wide by seven-high pixels

3.4 Legibility Distance - Distance at which a motorist with normal vision can read a message.
3.5 Cold Weather Test Deck – Deck location where the average daily temperature during performance testing is in the low 40’s.

Hot Weather Test Deck – Deck location where the average daily temperature during performance testing is in the upper 80’s.

4. **PRODUCT REQUIREMENTS**

4.1 The manufacturer shall submit to the NTPEP Manager the Product Evaluation Form (PEF), product literature, MSDS information, and program payment for each product submitted for testing.

4.2 **Technical Desk Audit & Verification** – Prior to the evaluation, the manufacturer shall provide the following information to aid in describing the sign(s) evaluated in accordance with the work plan. This information is not an attempt to replace the manufacturer’s technical manual but to only serve as a quick reference to the member states to compare features of the signs. Whenever practical, the Lead State will verify the accuracy of the following information.

4.2.1 **Sign Panel**

4.2.1.1 What is the display matrix type? (e.g., Full Matrix, Continuous Line Matrix, Character Matrix.)

4.2.1.2 What is the LED angularity specification?

4.2.1.3 How many LEDs (pixels) are there per matrix?

4.2.1.4 What is the maximum number of 5x7 characters per line?

4.2.1.5 What is the height and width (inches) of the 5x7 character matrix?

4.2.1.6 What is the spacing (inches) between characters?

4.2.1.7 What is the display panel size in inches?

4.2.1.8 What is the sign panel rotation capability?

4.2.1.9 Does the sign panel have an alignment-sighting device?

4.2.1.10 Does the electro-hydraulic sign panel lift have a manual backup system? If yes, standard or optional?

4.2.2 **Power System**

4.2.2.1 Are there onboard diagnostics to check the charging status of the solar array?

4.2.2.2 Are there onboard diagnostics to check the voltage output status of the battery-bank system?

4.2.2.3 Can solar panels be tilted?

4.2.2.4 List the available solar panel wattage outputs.
4.2.2.5 List the standard number of batteries in the battery-bank.

4.2.2.6 List battery type. (Indicate 6 or 12 V.)

4.2.2.7 What is the standard battery-bank capacity? (Indicate the Ah@12Vdc, 20 hour rating.)

4.2.2.8 Does the sign have an outlet for AC power capability? (If yes, indicate standard, optional or only with battery charger.)

4.2.2.9 Is a battery charger standard or optional? What is the amp output?

4.2.2.10 What is the typical recharging time for the standard battery-bank? (Indicate time with the associated amp output of charger.)

4.2.2.11 Is the battery-bank stored in a lockable vandal resistant enclosure?

4.2.2.12 Is the battery-bank enclosure weatherproof or weather-resistant?

4.2.3 Controller System

4.2.3.1 What type is the controller input device? (e.g., keyboard, keypad, handheld, or other.)

4.2.3.2 Is the input device lighted? (If yes, backlit or external?)

4.2.3.3 Is the controller display/panel lighted? (If yes, backlit or external?)

4.2.3.4 Does the controller use a menu driven program?

4.2.3.5 Does the controller have password protection?

4.2.3.6 Does the controller have multi-level password protection?

4.2.3.7 Does the controller include software for testing the modules/characters?

4.2.3.8 Does the controller software include a quick-program feature?

4.2.3.9 Does the controller software include a programmable default message?

4.2.3.10 If the sign loses power, does the controller software have an auto-resume feature when the sign regains power?

4.2.3.11 List the number of pre-programmed messages.

4.2.3.12 List the number of user programmable messages.

4.2.3.13 What is the message display time intervals for message phasing? (Indicate min. to max. intervals with time increments.)

4.2.3.14 How many messages can be displayed sequentially?

4.2.3.15 Can the message be flashed? (If yes, indicate flash time intervals.)
4.2.3.16 Is there manual dimming capability?
4.2.3.17 What is the method for updating controller software? (e.g., via laptop, factory technician, etc.)
4.2.3.18 Is the controller stored in a lockable, vandal resistant enclosure?
4.2.3.19 Is the controller enclosure weatherproof or weather-resistant?

4.2.4 Trailer
4.2.4.1 What are the brake options? (e.g., surge, electric, or both.)
4.2.4.2 Is there a tongue wheel option?

4.2.5 General Specifications
4.2.5.1 What is the operating temperature?
4.2.5.2 What is the nominal operating height?
4.2.5.3 What is the maximum wind load of sign when extended?
4.2.5.4 What is the maximum towing speed in the transport position?
4.2.5.5 What are the overall dimensions (L x W x H inches) in the transport position?
4.2.5.6 What is the gross weight?
4.2.5.7 What is the tongue weight?

4.3 Manufacturer’s Configuration of Signs – Signs submitted shall be solar powered and in compliance to the standards as stated in Section 6F.60 of the 2009 Manual on Uniform Traffic Control Devices (MUTCD). The manufacturer shall configure their sign(s) as follows:

4.3.1 The sign shall display three lines with a minimum of eight characters per line. Each character shall be five pixels wide and seven pixels high. Full Matrix and Continuous Line Matrix signs shall be preprogrammed to meet the above.

4.3.2 The sign shall be set to automatic dimming.

4.3.3 The battery backup system shall be comprised with the standard number of batteries and amp-hour capacity as specified in the sign’s technical specification. Optional battery-banks or higher amp-hour rated batteries will not be permitted.

4.3.4 The manufacturer shall install an accessible switch to disable the solar array.

4.3.5 The manufacturer shall install a sighting device to aid in the set up for the field evaluations.

4.3.6 Programmed “Low Voltage” verbal messages or graphic warnings on the display shall be disabled. Warning messages on the Controller unit are acceptable and shall not be disabled.

4.3.7 The solar array output (Watts) of each sign shall be determined by the manufacturer and shall be
appropriate for the climate of the Lead State.

4.4 **Manufacturer's Documentation** – Upon submittal to the NTPEP, the manufacturer shall supply documentation (i.e., manual, specification, etc.) prior to testing. This documentation will not be returned. A configuration sheet of the submitted sign shall also be included. The configuration sheet shall contain as a minimum the following items:

4.4.1 Model name and/or model number.
4.4.2 Login password.
4.4.3 Instructions for disconnecting solar array.
4.4.4 Solar panel wattage output being tested.
4.4.5 “Shutdown” and “Startup” voltages for the battery backup system.
4.4.6 Battery manufacturer with battery model number and amp-hour rating (Ah@12Vdc, 20 hour rating).
4.4.7 Any available options.

5. **SAMPLING PROTOCOL**

5.1 The lead state contact person will make arrangements to have the products submitted for evaluation. The manufacturer/supplier shall attach product/material literature and material data safety sheets to the PEF. All products shall be labeled to show the manufacturer and the manufacturer’s product name and/or code and shall be shipped by and at the manufacturer’s expense. The manufacturer will be responsible for transportation of the products to the appropriate testing facility.

5.2 Immediately following the product submittal deadline, letters will be sent to all participants with product delivery procedures. The manufacturer will have 14 days from the close of the submittal deadline to have all products delivered to the cold weather test deck.

**Note 1:** The manufacturer is advised to prepare the sample for delivery as soon as possible. Do not wait for the product delivery procedure letter.

5.3 Upon completion of the cold weather performance and sight tests, the manufacturer will be notified and have 14 days to have their sign(s) delivered to the hot weather test deck for performance testing.

5.4 The manufacturer is responsible for the sign(s) functioning properly when delivered to the test deck. When the sign is delivered, it is suggested that a technician arrive with the sign to verify its operation.

6. **SIGN VERIFICATION**

6.1 All signs shall be checked for the requirements as specified in Section 4.3 and Section 4.4. If signs are found not meeting the stated requirements, the manufacturer shall be given the opportunity to satisfy the requirements before testing begins per the guidelines outlined in Section 7 – Inoperable Signs.
7. INOPERABLE SIGNS

7.1 Signs that become inoperable before the Section 8 – Sight Tests, the Section 9 – Performance Tests or the Section 10 – Shutdown Tests can be repaired.

7.2 The manufacturer shall be given 48 hours from the time of notification to have the inoperable sign repaired. The manufacturer shall supply details of the repair to the Lead State. A letter stating the sign is now fully functional and the repairs made will not negatively affect the functionality of the sign. These details will be stated in the final report.

7.3 If the repairs are not performed within the allotted time frame the device will not be evaluated during the submitted cycle and half of the evaluation fee will be forfeited.

8. FIELD EVALUATIONS - SIGHT TESTS (VISIBILITY, LEGIBILITY AND ANGULARITY)

8.1 Test Conditions – Place the sign at the end of a long flat road surface displaying a three line message that shall be viewed by three evaluators. Driving a sedan toward the sign, three evaluators shall check the sign for visibility, legibility and angularity. Using their best judgment, each evaluator shall record a distance for each test. The evaluators shall perform a daytime and nighttime evaluation for each sign.

8.2 Evaluators and Test Vehicle – Tests shall be conducted using three evaluators with 20/20 corrected vision sitting in a sedan-style vehicle. The vehicle shall be equipped with an onboard distance meter for distance measuring. The vehicle shall not exceed 10 mph during the test. Report type of vehicle used.

8.3 Test Deck and Conditions – The test deck shall be surveyed and marked as shown in Annex A1. The evaluation shall be performed on a flat road surface in clear cloudless weather (or the best weather conditions possible) in a setting free from outside visual influences (i.e., city lights, billboards, etc.). Report test dates, weather conditions and location of test deck.

8.4 Sign Setup – The sign shall be fully operational in accordance with the manufacturer’s instructions. The sign shall be positioned as shown on the test deck layout and leveled by adjusting the jack stands. The display panel shall be raised to its highest position, set for automatic dimming mode and aimed per manufacturer’s instructions.

8.5 Message Content – The message shall be three lines- two lines that use non-traffic related words and one line that uses letters that do not form a word (e.g., eye chart). In all cases and without using all characters in a single line, between 75 to 85 percent of the total available characters of the three lines should be illuminated. A different message shall be created for each sign.

8.6 Site Test Procedure – The evaluators shall be performing a daytime and nighttime evaluation for each sign as directed in the following subsections. A message programmed for that sign as described above shall be different for each evaluation. The evaluators shall be seated in the sedan at the same time and, in one run, perform all tests for that sign. Per their judgment, each evaluator shall record a distance for each test. (During the Legibility test, each evaluator shall record the distance when both the two non-traffic words become legible and the distance when the “eye chart” word becomes legible.) The evaluators shall take turns driving during the Visibility and Legibility test but each shall be in the driver’s seat during the Angularity test. To insure accuracy during the Angularity test, each evaluator shall reset the onboard distance meter at the 200-foot
mark (see test deck layout in Annex A1). Each evaluator shall record the time, weather condition, message and distance for each test.

8.6.1 **Visibility** – Starting at point “f” which is 25 feet from the center of the sign face and 4800 feet from point “x” (see Annex A1 and Figure 1) determine whether or not the sign message is visible. If not, move toward point “x” along a line perpendicular to the sign face until the message is visible. The sign message is considered visible whenever the message portion is apparent, though not necessarily legible. Report the average of Visibility distances recorded.

8.6.2 **Legibility** – Starting at point “f” which is 25 feet from the center of the sign face and 4800 feet from point “x” (see Annex A1 and Figure 1), attempt to read the sign message. If necessary, move toward point “x” along a line perpendicular to the sign face until all lines of the message is legible. Measure the distance “d” from the first point of legibility to point “x”. Report the average of Legibility distances recorded for the two non-traffic word message and the “eye chart” message.

8.6.3 **Angularity** – Starting at point “h” which is 25 feet from the center of the sign face and 200 feet from “x” (see Annex A1 and Figure 2), move on a line perpendicular to the sign face until a character in the sign message is no longer legible. Measure the distance “d” from point “x” to the point of legibility. Record this number and calculate the angularity of the angle θ shown. Report the average of the Angularity distances recorded and the calculated angle. The angle shall be reported as a 1/2 angle measurement.
9. FIELD EVALUATIONS - PERFORMANCE TEST

9.1 Test Deck and Conditions – Signs shall be tested concurrently on a flat surface with signs placed as not to affect the performance of other signs during testing. Report test deck location and daily weather conditions during the testing period.

9.2 Sign Setup – The sign is to be leveled by adjusting the jack stands. The display panel shall be raised to its highest position and set for automatic dimming mode. Report the solar array output (Watts) and battery-bank configuration- number of batteries, manufacturer, model number and total amp-hour capacity (Ah@12Vdc, 20 hour Rating).

9.3 Message Content – Without using all the characters in a single line, program the sign with a static three line message that uses between 75 to 85 percent of the total characters of the three lines to be illuminated.

9.4 Performance Test – The same message shall be programmed on each sign included in the evaluation. Before the beginning of each test, verify that all signs are operational and functioning properly.

9.4.1 Record the beginning voltage level of the battery-bank for each sign by using the Open-Circuit Voltage Test Procedure outlined in Section 9.5. Record the starting date and operate the sign with the programmed message continuously for 30 days in accordance with the manufacturer’s instructions. Raise and lower the display panel two times each week during the test period.

9.4.2 At the end of the 30 days, stop the test and repeat the Open-Circuit Voltage Test Procedure to record the ending battery-bank voltage level.

9.4.3 Report the testing period dates and the beginning and ending battery-bank voltage levels. Report any failures or significant problems and the associated date.

9.5 Open-Circuit Voltage Test

9.5.1 Turn sign to off mode (i.e., display, controller, etc.).

9.5.2 Disconnect the solar array either by a switch or quick-disconnect connector as instructed by the
9.5.3 Leave the sign in the above state for a minimum of 6 hours, but do not exceed 24 hours before checking voltage level.

9.5.4 Check the sign’s voltage level by running the onboard diagnostics and by measuring the battery-bank with a digital voltmeter.

9.5.5 Voltage shall be measured to the nearest hundredth of a volt. Use a digital voltmeter if onboard diagnostics are not provided.

Note 2 – For safe operation and to prevent damage to sign, contact the manufacturer for instructions on how to correctly measure the voltage level with a voltmeter.

10. FIELD EVALUATIONS - SHUTDOWN TEST

10.1 Test Deck and Conditions – Signs shall be tested concurrently on a flat surface with signs placed as not to affect each other’s performance during testing. Report test deck location and daily weather conditions during the testing period.

10.2 Sign Setup – The sign is to be leveled by adjusting the jack stands. The display panel shall be raised to its highest position and set for automatic dimming mode. Report the solar array output (Watts) and battery-bank configuration- number of batteries, manufacturer, model number and total amp-hour capacity (Ah@12Vdc, 20 hour Rating).

10.3 Message Content – Without using all the characters in a single line, program the sign with a static three line message that uses between 75 to 85 percent of the total characters of the three lines to be illuminated.

10.4 Shutdown Test – The same message shall be programmed on each sign included in the evaluation. Before the beginning of each test, verify that all signs are operational and functioning properly.

10.4.1 Following Performance testing, disconnect the solar array either by a switch or quick-disconnect connector as instructed by the manufacturer. Record date the sign was disconnected from the solar array.

10.4.2 Continue operating the sign with the programmed message until the sign shuts down and ceases to display the message. Monitor the signs a minimum of every two days and record the date and voltage level when a sign is found non-operational.

10.4.3 The Shutdown test shall be limited to 30 days. If it becomes apparent that a sign will operate substantially past 30 days, contact the manufacturer for the best means for accelerating the discharging of the battery-bank. Once the sign passes the 30 day mark, modify the sign setup per the manufacturer’s instructions and continue to monitor the sign until it shuts down.

Note 3 – Because it is a requirement that the sign cannot be configured with an enhanced battery backup system, the resulting days of operation will be an approximate indication of the sign’s battery backup system capacity.

10.4.4 Reconnect the solar array and charge to operational voltages. Once recharged, verify the programmed message still exists in the system controller, and the sign functions properly. Report
the number of days the sign operated on battery backup, the “shutdown” voltage set by the manufacturer and the voltage level found at shutdown. Include a graph of the recorded voltages in the report that illustrates the power consumption of the sign during the testing period. If the sign was intentionally shut down due to the 30 day limitation for testing, include a statement to that effect in the test report summary and only graph that period of the operation. *Report any failures or significant problems and the associated date.*

11. EVALUATION RESULTS AND DATA

11.1 Test results from both the cold and hot weather test decks will be reported to the NTPEP Manager in the web-based data base – DataMine as follows. Once the data is reported to the manager, he will forward each manufacturer’s data for their review. When the manufacturer reviews and accepts the data, the NTPEP manager will release the data to the public.

11.2 Evaluation data will be compiled and made available to all participating states and testing companies through the AASHTO/NTPEP DataMine. This report will include data only. No judgment as to a product’s acceptability will be made in this report. End user participants will establish individual criteria for product acceptability.

11.3 *DataMine* – This web-based data base can be accessed through the AASHTO-NTPEP web site link at [www.ntpep.org](http://www.ntpep.org).

11.4 In the event that a vendor decides to withdraw its sign during testing, all test results recorded up to the withdrawal will be reported. The vendor will be given the opportunity to explain the decision for withdrawing its sign in the final report.

12. EVALUATION FREQUENCY

12.1 Following the initial testing, resubmittal testing frequency is at the option of the manufacturer.

13. TIMELINE

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14. **KEYWORDS**

14.1 Changeable message signs; DataMine; message signs; NTPEP; portable changeable message signs; portable message signs
A1. TEST DECK LAYOUT