Specification for Reflectometer for determining the coefficient of retroreflected luminance of pavement markings

1. MEASUREMENT PARAMETERS:

   1.1. Geometry: The retroreflectometer (instrument) shall be constructed to simulate the driver observation angle found at a 30-meter distance from the marking and in accordance with ASTM E 1710.

      1.1.1. Entrance angle of 88.76 degrees.

      1.1.2. Observation angle of 1.05 degrees.

   1.2. Working Range: The instrument shall have a working range of 0 to 2,000 $mcd \cdot m^{-2} \cdot lx^{-1}$.

   1.3. Marking Types & Conditions: The instrument shall be capable of measuring retroreflectivity on planar (flat) and profiled (textured) markings under both wet and dry conditions. The instrument shall be able to measure in accordance with ASTM E 2176 and E 2177. The instrument shall be capable of compensating for stray light allowing for full daylight measurements.

   1.4. Depth Ability - Profile Markings: The instrument shall have a depth ability which enables the instrument to accurately measure profile pavement markings in accordance with ASTM E 1710 with a profile height/depth of up to 0.6 in. (15 mm).

   1.5. Measurement Fields: The instrument shall utilize an illumination field that is wholly contained within the observation field. The instrument shall measure the retroreflectance of an area of at least 7.87 in. (200 mm) in length by 1.77 in. (45 mm) in width.

   1.6. Measurement: The instrument measurement shall include the following data: Retroreflectivity (R_l); GPS coordinates of measurement location with number of usable satellites, horizontal dilution of precision, and fix/no fix; date and time; averaging data with series size and series count; marking icon; series ID; user ID; temperature and relative humidity.

   1.7. Illumination and Detection: The instrument shall utilize a system response illuminant type 'A' and CIE observer sensitivity.

   1.8. Positioning Data: The instrument shall include the following as a minimum to qualify itself as GPS capable:
      1.8.1. The coordinates of the location of the instrument shall be recorded with each measurement of retroreflection.
      1.8.2. The instrument will measure, display, and record, along with the position coordinates, the number of satellites used to determine such coordinates for each reading and the horizontal dilution of precision.
      1.8.3. The GPS receiver must receive all operational power from an internal supply source.
      1.8.4. The GPS receiver shall be contained wholly within the reflectometer housing.
      1.8.5. The accuracy of the GPS data under optimal conditions shall be 6.5 ft. (2.0m) CEP.

2. CALIBRATION / ACCURACY:

   The instrument shall be supplied with two calibration standards as described below.

   2.1. Field Calibration: The instrument shall be supplied with a working field calibration assembly, which contains a working reflection standard and a light trap for field calibration purposes.

   2.2. Traceable Calibration: The instrument shall be supplied with a master calibration assembly, which is made up of a light trap and a calibrated reflection standard. The calibrated reflection standard must be traceable to an accredited national standards laboratory through an ISO17025 certified testing and calibration laboratory. A certificate of conformance and traceability shall also be supplied with the traceable master calibration reflection standard.

   2.3. Calibration Standards: Both of the reflection standards shall be made of a durable diffuse reflector without glass beads that is uniform and consistent across the whole reflector face.

   2.4. Stray Light Compensation: The instrument shall actively detect for and compensate for the normal level of stray light present as part of each retroreflectivity measurement.

   2.5. Color Correction: The instrument shall be internally color corrected to allow measurement of various colored markings without requiring recalibration using colored reflection standards. The color correction shall comply with ASTM E 1710 section 6.3.2 for selected filters.

   2.6. Water Spray Protection: To avoid build-up of water droplets on the optical window (causing inaccurate readings) when taking readings in accordance with ASTM E 2176, any part of the instrument's measurement field shall for such readings be no closer to the optical window than 17.3 in. (440 mm). The instrument shall have a built-in shield which prevents the ASTM E 2176 water spray to get no closer to the optical window than 16.5 in. (420 mm).

   2.7. Repeatability: The repeatability of measurements taken with the instrument shall be within 2%.

   2.8. Reproducibility: The reproducibility of measurements taken with the instrument or other like instruments shall be within 5%.

3. CONSTRUCTION:

3.1. Basic Construction: The instrument shall be constructed with an internal metal frame to which the illumination and observation sources shall be mounted in order to maintain a fixed geometry. The instrument shall have an external shell made of impact resistant plastic.

3.2. Wheels: The instrument shall come with semi-permanent wheels.

3.3. Portability: The instrument shall be completely self-contained with no external battery packs or electronic components. The handle assembly must be retractable to the instrument body when not in use.

3.4. Dimensions: The instrument's physical dimensions, excluding any detachable, folding or extending parts, shall be 22.6 in. (573 mm) long; 8.7 in. (222 mm) wide; 21.2 in. (538 mm) high.

3.5. Power Source: The instrument must be powered by a built-in 12 volt/4.5 Ah High Power battery.

3.6. Electronics Shielding: The instrument shall comply with FCC-CFR47 part 15 class to be fully shielded to eliminate external electromagnetic interference with its performance and block internal electromagnetic radiation.

3.7. Optics: The optics of the instrument shall be fixed within the aluminum frame, totally enclosed and protected by a sealed glass window.

3.8. Display Shield: The instrument shall be provided with a retractable shield that will protect the display when the unit is not in use. The shield shall be fabricated from aluminum in such a manner as to cover the display in to its furthest extent.

4. USE AND CONTROL:

4.1. Keyboard Panel: Use of the instrument shall be through the use of programmed control buttons, directional navigation buttons, and a liquid crystal display.

4.2. Multilingual: The instrument shall have the self-contained ability to output display menus and readings in English and Spanish.

4.3. Ease of use: The unit shall have an ergonomic handle/interface design, which will afford the user a single-handed operation.

4.4. Timing: The instrument shall be able to take a single measurement in 1 second and have a maximum required time between measurements of 2 seconds.

4.5. Data Storage: The instrument shall utilize internal non-volatile memory for storing measurement data. The instrument shall be capable of collecting 200,000 measurements. The GPS data shall be stored internally along with each retroreflectivity measurement. Each stored measurement must be identifiable by way of a series identifier, user identifier, and a marking type icon. The instrument shall be capable of storing the temperature and relative humidity at time of reading.

4.6. Data Output: The instrument shall contain a built in thermal printer capable of providing a paper printout of individual measurement and averaging details or stored measurements, either for immediate on-site use or at a later time. The instrument shall be equipped with a serial interface port to allow for software compatible data output, extended control, calibration and diagnostics. The GPS data shall be shown on the display screen and printed out with the individual measurement.

4.7. Internal Error Detection: The instrument must indicate on the display, print-out, and data log whenever detectable errors exist, such as excessive stray light, low battery or incorrect calibration.

4.8. GPS Fix: The instrument during normal use must advise the operator if the GPS fails to have a fix when a reading is taken. The operator shall be given the options of a) taking the measurement anyway, b) not taking the measurement, or c) turning off the GPS function.

5. EQUIPMENT:

5.1. Standard Accessories: The instrument shall be equipped complete with a user's manual, quick guide, battery charger, battery, carrying case with wheels, printer paper, wheel assembly, interface software, communications cable, working reflection standard and a calibrated master reflection standard.

6. TECHNICAL SUPPORT & SERVICE:

6.1. Training: The manufacturer and/or authorized representative shall provide training and/or technical service as required by the purchaser or his appointed representative. The successful bidder must provide no less than three hours of on-site training within two weeks of receipt of the instrument(s), or at a time requested by the purchaser or his appointed representative.

6.2. Factory Services: The instrument must have a factory certified maintenance program available for yearly service checks to verify instrument performance and reference standard condition.

7. WARRANTY:

7.1. Warranty Period: The instrument shall be warranted for a period of one year against defective parts and workmanship.