Andy Beshear
GOVERNOR

TRANSPORTATION CABINET
200 Mero Street
Frankfort, Kentucky 40601

Jim Gray
SECRETARY

January 11, 2023

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ADDENDUM # 1

Subject: Various Counties, FE01 121 DW23 0050000
Letting January 26, 2023

(1) Added – Special Note - Pages 27A-27H of 53
(2) Revised – Proposal Bid Items – Page 53 of 53

Proposal revisions are available at http://transportation.ky.gov/Construction-Procurement/.

If you have any questions, please contact us at 502-564-3500.

Sincerely,

Rachel Mills,

Rachel Mills, P.E.
Director
Division of Construction Procurement

RM:mr
Enclosures

RETROREFLECTOMETER

Furnish three (3) new LTL3500 Retroreflectometers or equal:

DELTA - a part of FORCE Technology
Venlighedsvej 4
2970 Horsham
Denmark
Tel. +45 43 25 14 00
roadsensors@forcetechnology.com
roadsensors.com

Deliver one (1) Retroreflectometer to the Engineer at the District 5 District Office at 8310 Westport Road, Louisville, KY 40242, within 2 weeks of striping operations beginning on the project.

Deliver two (2) Retroreflectometers to the Engineer (attention Brandi Mitchell) at the Division of Materials 1227 Wilkinson Blvd Frankfort, KY. 40601, within 2 weeks of striping operations beginning on the project.

Specification for Retroreflectometer for determining the coefficient of retroreflected luminance (R_L) and the luminance coefficient under diffuse illumination (Qd) of pavement markings

LTL3500 retroreflectometer

1. MEASUREMENT PARAMETERS AND FEATURES:

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.

- Entrance angle of 88.76 degrees
- Observation angle of 1.05 degrees

and in accordance with EN 1436

- 1.1.3. Entrance angle of 1.24 degrees
- 1.1.4. Observation angle of 2.29 degrees

1.2. Compliance with standards:
LTL3500 comply with the following standards

- EN 1436 (R_L, Qd; Dry, wet and continuous wetting; Nighttime Chromaticity colors (x,y)
- ASTM D6628 (Color of pavement markings)
- ASTM E1710 (R_L dry)
- ASTM E2177 (R_L wet)
- ASTM E2302 (Qd)
- ASTM E2367 (Nighttime chromaticity of pavement markings)
- ASTM E 2832 (R_L continuous wetting)

1.3. Illumination and Detection: The instrument shall utilize a system response illuminant type 'A' and CIE observer sensitivity according to ASTM E 1710 and EN 1436. The instrument is equipped with a long-life illumination system based of LED.

1.4. Working Range: The instrument shall measure retroreflection of road markings and shall have a working range of 0 to 4.000 $mcd \cdot lx^{-1} \cdot m^{-2}$ for R_L and 0 to 318 $mcd \cdot lx^{-1} \cdot m^{-2}$ for Qd.

1.5. Marking Types & Conditions: The instrument shall be capable of measuring retroreflectivity on planar (flat) and profiled (textured) markings under dry conditions, wet conditions and under continuous wetting. The instrument shall be capable of automatic compensating for stray light allowing for full daylight measurements.

1.6. Depth Ability - Profile Markings: The instrument shall have a depth ability which enables the instrument to accurately measure profiled road / pavement markings in accordance with R_L profile height / depth of up to 0.6 inch / 15 mm.

1.7. 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 7.1 inch /180 mm in length by 2.0 inch / 50 mm in width.

1.8. Measurement: The instrument measurement shall include the following data: Retroreflectivity (R_L & Qd, Qd optional); date and time; series ID; user ID; Temperature and humidity; Road icon reference; GNSS, coordinates of measurement location (optional); Nighttime chromaticity coordinates (x.y) (optional); Orientation and tilt (optional).

1.9. Nighttime Chromaticity Coordinates (x,y): The instrument shall be able to measure measures nighttime retroreflected color – CIE chromaticity for white and yellow markings according to EN1436, ASTM D6628 and ASTM E 2367. The instrument is calibrated to measure white and yellow Marking color coordinates correctly.

1.10. Positioning Data: The instrument shall include the following as a minimum to qualify itself as GNSS capable (GPS, Galileo, GLONASS, BeiDou satellite systems, optional):

- Latitude / longitude: Decimal degrees
- Datum: WGS 84
- The coordinates of the location of the instrument shall be recorded with each measurement of retroreflection.
- The instrument will measure, display, and record, along with the position coordinates, the number of satellites used to determine such coordinates for each reading.
- The GNSS receiver must receive all operational power from an internal supply source.
- The GNSS receiver shall be contained wholly within the retroreflectometer housing.
- The accuracy of the GNSS data under optimal conditions shall be 6.5 ft. / 2.0m CEP (Circular Error Probability).

1.11. Additional measurement support features:
The following additional features can be offered with LTL3500:

- Macro camera (optional) for close-up pictures of the measurement location
- Overhead camera (optional) for overview pictures of the markings measured.
- Instrument orientation and tilt (optional)
- External printer (optional) for on-location documentation of measurement results
- Daylight contrast
- IR based marking temperature
- Pass/fail indicator for R_L and Qd
- External printer

2. CALIBRATION / ACCURACY:

2.1. Traceable Calibration: The instrument shall be supplied with a R_L master calibration assembly, which is made up of a plate and a calibrated ceramic reflection standard. The calibrated reflection standard must be traceable to an accredited national standards laboratory through an ISO17025 certified testing and calibration laboratory. A DANAK accredited calibration certificate shall be supplied with the traceable calibration reflection standard.

2.2. Calibration Standards Qd: The instrument shall be supplied with a Qd calibration marking for Qd verification and calibration if required.

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

2.4. Color Correction: The instrument shall be internally color corrected to allow retroreflection measurement of white and yellow markings without requiring recalibration using colored reflection standards.

2.5. Repeatability: The repeatability of measurements taken with the instrument shall be within +/- 2%.

2.6. Reproducibility: The reproducibility of measurements taken with the instrument or other similar instruments shall be within +/- 5%.

3. CONSTRUCTION:

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

3.2. Portability: The instrument is completely self-contained and powered by a replaceable battery.

3.3. Dimensions & weight: The instrument's physical dimensions is:

- Length: 18.0 inch / 470 mm
- Width: 5.9 inch / 150 mm
- Height: 11.0 inch / 280 mm

The instrument fully equipped has a weight of 5.6 kg / 12.3 lbs.

3.4. Power Source: The instrument is be powered by a rechargeable and replaceable Li-Ion battery. The instrument make use of a 12 V / 3.0 Ah professional Bosch battery.

3.5. Display: The instrument comes with a 5.0'' high brightness color touch display, which is clearly visible in daylight and during sunshine. The display has a resolution of 800 x 480 pixel. The display functions are supported by 3 rugged activity buttons.

3.6. Macro camera & overhead camera (optional)**:** The instrument can be equipped with a macro camera for close-up pictures of the markings showing the glass bead spread, numbers and embedment. The instrument can be equipped with an overhead camera which will allow a picture of the road markings being measured. Pictures taken with the cameras can be linked to the measurement. The cameras used has a resolution of 5 Mega Pixels (2592 x 1944 pixels).

3.7. Operating and storage range, humidity: The instrument can function within the following temperature rage:

- Operation: 0ºC to +60ºC / +32ºF to +140ºF
- Storage: -10ºC to +60ºC / +14ºF to +140ºF

It is recommended that the instrument is being stored below +30ºC / +86ºF to conserve the battery best possible.

It is recommended to operate the instrument at relative humidity levels below 85% to ensure there is no condensation on the window underneath the instrument where light passes during measurement.

The instrument can be operated in altitudes up to 4.000 m / 13.000 feet.

3.8. Electronics Shielding: The instrument complies with EN 301-489-19 V2.1.1 (2019-04) and FCC-47 CFR part 15B (class B) to eliminate external electromagnetic interference with its performance and block internal electromagnetic radiation.

3.9. Safety: The instrument complies with IEC 61010-1:2010, AMD1:2016; EN 61010-1:2010 +A1:2019 in respect to safe use of the instrument.

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

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

4. USE AND CONTROL:

4.1. Keyboard Panel: Use of the instrument is through a color touch display and three activity buttons / navigation buttons.

4.2. Multi-lingual: The instrument can display menus and readings in many languages, for example but not limited to: English, French, German, Italian, Polish, Russian and Spanish. Additional languages can be added over time.

4.3. Timing: The instrument has the capability to make combined R_L and Qd measurements simultaneous and in less than 1 second.

4.4. Data Storage: The instrument utilizes internal non-volatile 8 GB memory for storing measurement data. The GNSS data (optional) shall be stored internally along with each retroreflectivity measurement and support information. Each stored measurement must be identifiable by way of a series identifier and a user identifier.

4.5. Data Output: The instrument is equipped with a USB port and Wi-Fi interface to allow for easy transfer of data and diagnostics. The instrument is prepared for IOT. The GNSS data (optional) shall be linked to the individual measurements. Measurement data shall be presented in Excel and on Google Earth if GNSS is installed (optional)

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

4.7. GNSS Fix (optional): The instrument shall during normal use advise the operator if the GNSS fails to have a fix when a reading is taken. The operator will be given the options of a) taking the measurement anyway, b) not taking the measurement.

5. EQUIPMENT:

5.1. Standard Accessories: The instrument will be delivered complete with:

- Hardcase transportation box
- Quick guide
- Battery and battery charger
- Calibrated R_L accredited calibration standard
- Qd verification and calibration marking (if Qd has been purchased)
- USB memory stick for data transfer.

User manual and other support material is available via www.roadsensor.com under "Retroreflectometer products" and "LTL3500".

5.2. Optional Accessories: The instrument will come as a base unit model able to measure R_L. LTL3500 can be added one or more of the following options:

- Qd measurement.
- GNSS positioning
- Nighttime chromaticity coordinates (x,y)
- Macro and overview camera
- Orientation (compass, instrument tilt)
- External printer

6. TECHNICAL SUPPORT & SERVICE:

6.1. Training: The manufacturer and/or authorized representative will be able to provide training and/or technical service as required by the purchaser or his appointed representative either via instruction video, on-location presence or via Internet.

6.2. Instrument Services: The manufacturer must offer a factory certified maintenance program for regular service checks to verify instrument performance as well a repair service. These services can be carried out either by DELTA or by one of our certified service operators.

7. REGULATORY COMPLIANCE:

EU:
Radio: EN 303-413 V1.1.1:2017
EMC: EN 301-489-19 V2.1.1 (2019-04)
Safety: IEC 61010-1:2010, AMD1:2016; EN 61010-1:2010+A1:2019

USA:
FCC: 47 CFR Part 15B (class B)

Canada:
ICES-003:2016 (Class B)

8. WARRANTY:

The instrument shall be warranted for a period of two years against defective parts and workmanship.

LTL3500
Specifications

Optical specifications

Field of measurement:
- Width: 50 mm / 2 inch
- Hight: 180 mm / 7.1 inch

Illumination angle R_L EN 1436: 1.24°
Illumination angle R_L ASTM E 1710: 88.76°
Observation angle R_L EN 1436: 2.29°
Observation angle R_L ASTM E 1710: 1.05°
Illumination angle Qd: Diffuse
Illumination angular spread:
- Horisontal: / Vertical: 0.33 / 0.17°

Observation angular spread: ±0.17°
Equivalent observations distance: 30 m

R_L range (mcd·m^{-2}·lx^{-1}) 0 - 4000
Qd range (mcd·m^{-2}·lx^{-1}) 0 – 318

Instrument dimensions

Length: 470 mm / 18.0 inch
Width: 150 mm / 5.9 inch
Height: 280 mm / 11.0 inch
Weight: 5.6 kg / 12.3 lbs

Construction

Structural parts: Aluminum
Housing: Polymer
Keyboard: Silicone rubber & touch screen

Display

- 5" high brightness color touch display
- Resolution 800 x 480 pixels

Macro camera, overhead camera

- Macro camera for close-up pictures of markings
- Overhead camera for overview of markings
- Resolution 5 megapixels (2592 x 1944 pixels)

Regulatory compliance

EU:
Radio: EN 303-413 V1.1.1:2017
EMC: EN 301-489-19 V2.1.1 (2019-04)
Safety: IEC 61010-1:2010, AMD1:2016; EN 61010-1:2010+A1:2019

USA:
FCC: 47 CFR Part 15B (class B)

Canada:
ICES-003:2016 (Class B)

Electrical characteristics

Power supply:
Battery: Rechargeable and replaceable Li-Ion 12V 3.0 Ah
Charging time: Approx. 1 hour 15 min.
External chargers:
- 230 V / 50 Hz
- 120 V / 60 Hz

Data

Data memory: 8 GB
Data transfer: USB 2.0, Wi-Fi
Typical repeatability: +/- 2%
Typical reproducibility: +/- 5%

Environmental specification

Temperature:
- Operating: 0°C to +60°C / 32°F to 140°F
- Storage: -10°C to +60°C / 14°F to 140°F
- Humidity: 20 - 85%, non-condensing
- Altitude: 4000 m / 13.000 feet

Timing

Measurement time: <1 sec.

Standards

EN 1436 (R_L & Qd), ASTM E1710 (R_L), ASTM E2177 (R_L wet), ASTM E2302 (Qd), ASTM E2367 (night colors), ASTM 2832 (continuous wetting)

5350.5.22

General features

- Simultaneous R_L and Qd for dry & wet markings
- R_L for continuous wetting
- Measurement time less than 1 sec for both R_L and Qd
- Measures R_L on profiled markings up to 15 mm / 0.6 inch
- Ambient temperature and humidity
- Memory capacity 8GB
- Multi-lingual
- Average calculation
- Easy-readable color touch LED display with 3 buttons
- Long-life illumination system
- USB memory stick
- Wi-Fi prepared
- Power supply, standard Bosch professional battery
- Shows and stores date, time, air temperature, and humidity
- Facility for entering and storing road ID, user ID and other measurement related data
- Data presentation in Excel
- Stray light compensated
- Single handed operation, user-friendly
- "Time for Service" indicator
- Calibration reminder
- Wet timer
- Pass-fail Indicator

Optional features

- Qd
- Daylight contrast (requires Qd)
- Marking temperature
- Road Icon references
- GNSS positioning
  – Latitude / Longitude format: Decimal degrees
  – Datum: WGS 84
- Data presentation in Google Earth
- Nighttime color (x,y) for R_L measurements (white & yellow)
- Color Box reading
- Macro and overview cameras
- Orientation (compass, instrument tilt)
- Wi-Fi API & Web App (SW feature under development)
- User defined data linked to measurement (3rd party equipment)
- Add note to measurement
- External printer

Standard delivery

- LTL3500 Retroreflectometer
- Hard-case transportation box
- R_L calibration standard with DANAK certificate
- Qd calibration / verification marking (if Qd is ordered)
- Battery charger
- Quick guide
- USB memory stick

Downloads

User manual to be downloaded from www.roadsensors.com under 'Products' and 'User manuals':

Warranty

2 years

R&TTE Declaration of Conformity (DoC) and US Attestation of Conformity (AoC) can by supplied by DELTA upon request or viewed on: roadsensors.madebydelta.com/technical-background/certification
Specifications may be changed without notice.

DELTA - a part of FORCE Technology
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2970 Hørsholm
Denmark
Tel. +45 43 25 14 00
roadsensors@forcetechnology.com
roadsensors.com

A PART OF FORCE TECHNOLOGY

PROPOSAL BID ITEMS

Report Date 1/11/23

Section: 0001 - ROADWAY

LINE	BID CODE	ALT	DESCRIPTION	QUANTITY	UNIT	UNIT PRIC	FP	AMOUNT
0010	02572		QUALITY CONTROL	1.00	LS		$	
0020	02650		MAINTAIN & CONTROL TRAFFIC	1.00	LS		$	
0030	06520		PAVE STRIPING-WB PAINT-4 IN W RURAL SECONDARY ROUTES	348.67	MILE		$	
0040	06520		PAVE STRIPING-WB PAINT-4 IN W STATE PRIMARY, SECONDARY & SUPPLEMENTAL ROUTES	100.04	MILE		$	
0050	06521		PAVE STRIPING-WB PAINT-4 IN Y RURAL SECONDARY ROUTES	752.65	MILE		$	
0060	06521		PAVE STRIPING-WB PAINT-4 IN Y STATE PRIMARY, SECONDARY & SUPPLEMENTAL ROUTES	107.54	MILE		$	
0070	06522		PAVE STRIPING-WB PAINT-6 IN W RURAL SECONDARY ROUTES	213.92	MILE		$	
0080	06522		PAVE STRIPING-WB PAINT-6 IN W STATE PRIMARY, SECONDARY & SUPPLEMENTAL ROUTES	1,436.27	MILE		$	
0090	06523		PAVE STRIPING-WB PAINT-6 IN Y RURAL SECONDARY ROUTES	194.68	MILE		$	
0100	06523		PAVE STRIPING-WB PAINT-6 IN Y STATE PRIMARY, SECONDARY & SUPPLEMENTAL ROUTES	1,310.02	MILE		$	
0110	06526		PAVE STRIPING-WB PAINT-12 IN W STATE PRIMARY, SECONDARY & SUPPLEMENTAL ROUTES	16.04	MILE		$	
0120	20411ED		LAW ENFORCEMENT OFFICER	200.00	HOUR		$	
0130	22664EN		WATER BLASTING EXISTING STRIPE	2,000.00	LF		$	
0140	23138EN		RETROREFLECTOMETER DISTRICT 5	1.00	EACH		$	
0150	23140EN		DURABLE WATERBORNE MARKING-6 IN W INTERSTATE SYSTEM	509.92	MILE		$	
0160	23141EN		DURABLE WATERBORNE MARKING-6 IN Y INTERSTATE SYSTEM	303.71	MILE		$	
0170	26162EC		DURABLE WATERBORNE MARKING-12 IN W INTERSTATE SYSTEM	85.01	MILE		$	
0180	23138EN		RETROREFLECTOMETER DIVISION OF MATERIALS	2.00	EACH		$	

Section: 0002 - DEMOBILIZATION

LINE	BID CODE	ALT	DESCRIPTION	QUANTITY	UNIT	UNIT PRIC	FP	AMOUNT
0190	02569		DEMOBILIZATION	1.00	LS		$	