PPP, Inc.

# JACKSONVILLE AVIATION AUTHORITY MARKINGS CASE STUDY

JAA
Jacksonville
Aviation
Authority

UPDATED 2019

# JAA Airfield Markings Case Study

## The Problem

**Jacksonville Aviation Authority (JAA),** the organization responsible for the oversight of the Jacksonville International Airport (JIA) desired to improve the efficiency and effectiveness of their airfield pavement marking management program. They wanted to have a more data driven process to manage the markings. Currently, the re-marking decision is highly subjective and inexact. This makes the budgeting for both labor and materials very difficult and costly. In addition is the risk of falling out of FAA compliance.

## Potential Solution

**Professional Pavement Products (PPP)**, a two-decade industry leader in roadway safety innovation was able to bring a solution to the problem by employing technology widely used in the roadway safety industry. Using the highly sophisticated RoadVista line of retroreflectivity assessment instruments, which are tools used to measure retroreflectivity on roadway markings. They modified the instrument to accommodate the complicated and extensive markings that exist on an airfield. The task at hand was to measure the retroreflectivity (nighttime visibility) of the JIA airfield pavement markings in a fast, efficient and comprehensive way to ensure that all airfield pavement markings were being maintained at adequate visibility levels. This would allow management to make data driven decisions about re-marking.

Achieving the desired solution would take a team approach. The following individuals were major contributors:

| | |
|---|---|
| **Greg Driskell** | President of PPP (Chief Author of Case Study) |
| **Steve Norkus** | Retroreflective Technology Product Manager at PPP |
| **Eric Nelson** | Primary Product Manager at RoadVista, operator and technical specialist |
| **Patrick Spakausky** | Airside Operations Manager at Jacksonville Aviation Authority |
| **Evin Sweeney** | Airport Operations Officer at Jacksonville Aviation Authority |

## The Challenges

A number of environmental and operational challenges needed to be overcome for the project to be successful.

**Safety concerns**
Of course, safety was the primary concern as PPP was working around an active airfield. Careful communication between the vendor, ground level airfield personnel and the control tower were paramount.

**Accuracy**
The primary instrument of choice was the LLG7 Mobile Retroreflectometer. This instrument uses a high-speed laser that scans the markings 400 times per second at the 30-meter geometry used on roadway pavement marking assessments. Being that the instrument provides accurate and continuous assessment in speeds in excess of 100 mph; they were able to drive along the markings at maximum allowable speeds, while collecting accurate, continuous measurements.

Some special modifications of the instrument were needed to ensure efficiency in the measurement exercise. To further measure with accuracy, the handheld retroreflectometer, the **Stripemaster 2 Touch (SM2T**), was used on markings in which the mobile was unable to access effectively.

**Complexity of markings**
Airfield markings are far more complex compared to roadways. The team encountered extraordinary widths of markings (aiming points), multi-directional taxiway intersections (taxiway center lines) and multiple lines within a marking (runway boundaries, hold short lines). There was also lateral edge to edge lines (hold stop short bars), and many obstacles such as blast pad lighting.

**Time**
Each of the two runways and their primary taxiways were closed for a period of 3-hours, once per week. Due to the time constraints, PPP needed to work fast. In this project, 40 miles of markings needed to be measured in just (2) 3-hour windows. Working within these confines proved to be a challenge for PPP as these conditions do not exist on common roadways. This tight window of time was allotted to complete the entire retroreflectivity assessment including setup and break-down. This hard stop time is less than half of the time available for even the busiest of highway project equivalent.

## Project Goal and Scope

JAA worked in cooperation with PPP to achieve the goals of obtaining a numerical assessment thereby removing the subjectivity of "good" markings vs "bad". This would asist in the improvement of maintenance planning and budgeting and remaining in FAA compliance.

Provided these goals could be achieved, this would permanently change the current method of indiscriminate re-marking across the entire airfield area to a more sophisticated data driven process. Safety for airfield personnel, pilots, and passengers would increase, striping contractors could be held accountable and lastly it would save an estimated six-figures in labor and materials annually.

**The scope of the project meant measuring the following markings:**

1. Touchdown Zone
2. Aiming Points
3. Runway Centerline
4. Taxiway Centerline
5. Enhanced Centerline
6. Runway Edge Line
7. Taxiway Edge Line
8. Movement Boundary Line (Over 200 ft.)
9. Threshold Bars
10. Blast Pad Lines (Optional)
11. Lead-On Lead-Off Line

JAA
Jacksonville
Aviation
Authority


| 2016 | |
|---|---|
| Number of Passengers | 5.5 million |
| Aircraft operations | 96,000 |
| Runways | 2 |
| Square feet of markings | 486,000 |
| Linear feet of markings | 200,000 |

In 2016 alone, JIA had over 5.5 million passengers fly in and out of its airport and had over 96,000 aircraft operations. All of this was completed via two runways, 486,000 square feet of markings, and 200,000 linear feet of markings. JIA is considered a medium-sized hub and was ranked as the 57th busiest airport out of 506 by the FAA in 2016.

JAA is responsible for overseeing all of the operations and maintenance of JIA and three other airports including Jacksonville Executive at Craig Airport, Cecil Airport, and Herlong Recreational Airport.

**Surveying the challenges**

To begin the testing, PPP had to work with JAA to create counter-measures for the anticipated field-related challenges. While the overall airfield area was small, there were an extensive volume of markings with over 40 linear miles of markings needing retroreflectivity assessment. To provide continuous assessment, 38,000 data points would need to be recorded. Further was the challenge of the multi-directional and intersecting lanes that are not present with common roadways. Further, the team could not simply mark off an area with cones and signs and move about freely. Instead, all work and movement had to be planned, timed and highly synchronized. The team was required to move from zone to zone in coordination with the tower. Adding to the complexity they had to avoid other crews working in the same zone including electricians, maintenance workers and lighting technicians. Frequently, the work zone overlapped with active and inactive taxiways, so the team had to stay aware of their environment and alert to what was happening around them.

**Planning the day**

Prior to conducting the assessment in the field, a route plan was identified and established. A map of the entire airfield was marked up with a proposed route in order to maximize efficiency for both time and vehicle maneuvers. In the planning process it was identified that there had to be modifications made to the instrument including firmware, software and hardware. Also, due to FAA regulations and safety, the assessment required escorting by JAA personnel and the use of their vehicles.

Despite significant planning of countermeasures to address the challenges above, there were many unforeseen challenges that arose on the day of assessment. There was the need for re-routing due to other crews in the same zone, tight maneuvering of the vehicle, readjustment of instrument in the field, and weather.

**Selecting the tools**

When planning for the assessment in a series of pre-project meetings, it was decided that the team would use the StripeMaster 2 Touch (SM2T) handheld retroreflectometer, the LaserLux (LLG7) mobile retroreflectometer and visual assessment to evaluate the markings. The PPP team reviewed and collaborated with JAA on goals, methods and scheduling of the assessment. Together they also created expectations for the study, the data needs and the ultimate goal of the study which was to provide JAA with the data necessary to improve the efficiency and effectiveness of their marking maintenance program.

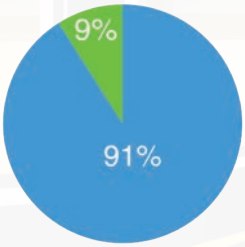
## Visual Assessment

Provides visual follow-up to retroreflectivity assessment for failure cause identification and characteristics not assessed by instrument including daytime visibility, paint adhesion, bead embedment and disbursement

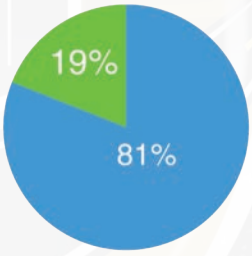
## StripeMaster 2 Touch Handheld Retroreflectivity Assessment


Provides an accurate numerical assessment of markings in which utilizing a mobile unit is impractical or not efficient

Primarily for shorter lateral markings less than 250 linear feet




**Used to measure 9% of runway**

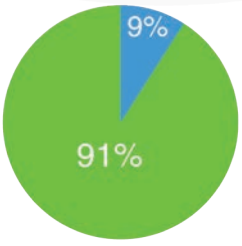



**Used to measure 19% of taxiway**

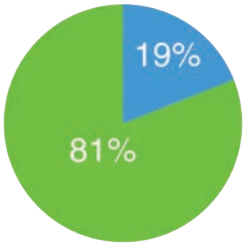
## LaserLux G7 Mobile Retroreflectivity Assessment


Allows for fast and comprehensive retroreflectivity assessment which reduces time on the runway and taxiway interruption

Primarily used for longitudinal markings and longer lateral markings greater than 250 linear feet




**Used to measure 91% of runway**




**Used to measure 81% of taxiway**

## Compiling the Data

Data was recorded integrating Google Satellite Maps and assigned a color to designate retroreflectivity performance.

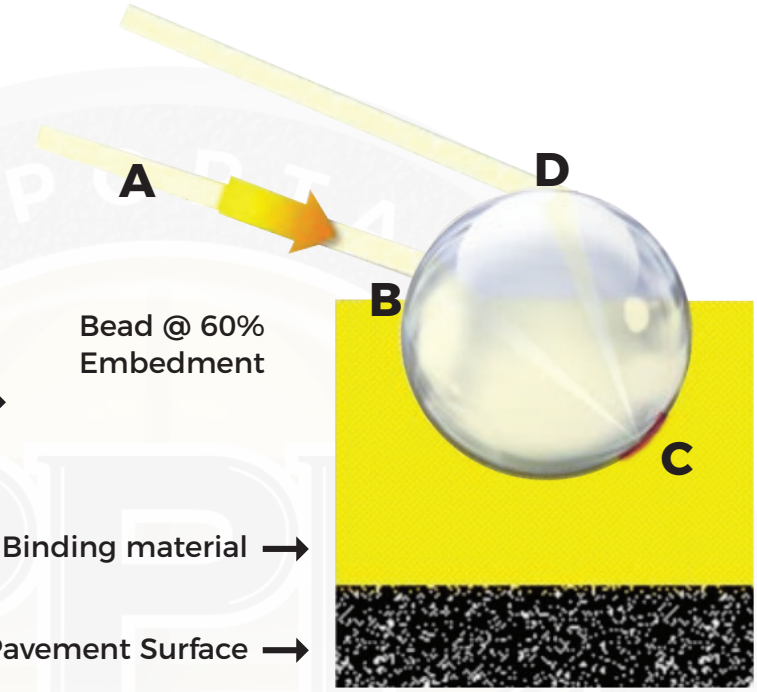
**Retroreflectivity**
Ability of an object (Stop sign) to redirect light back to its source (An automobile's headlights)

**A.** Light comes from source

**B.** Light bends (refracts) at point of entry of glass

**C.** Light reflects off back of glass bead taking the binding material's color with it

**D.** Light bends (refracts) again at point of exit of the glass bead




### Selected Level Ranges

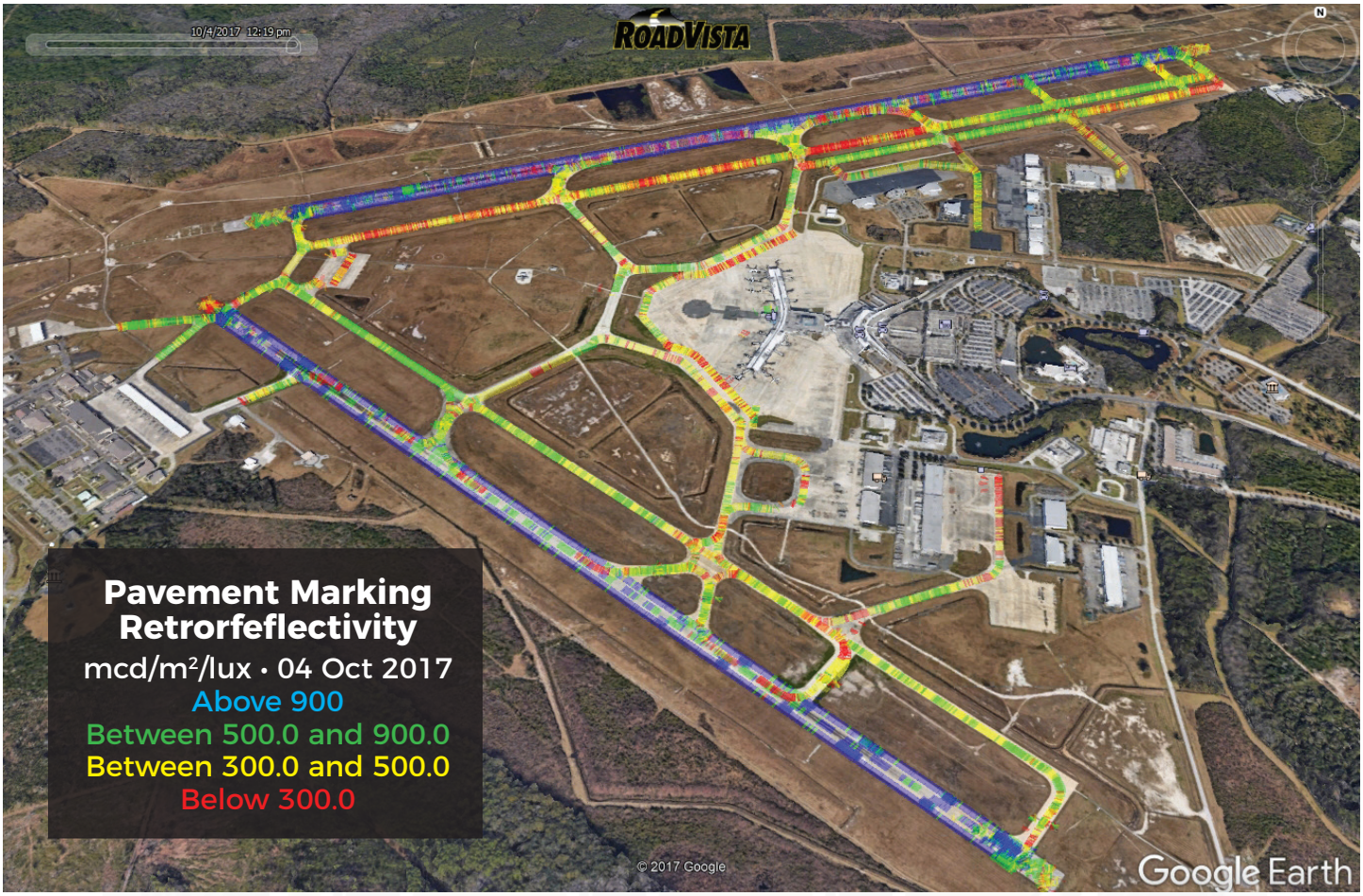
**Level 1**
**Below preferred minimum**
Measurement Range:
less than 300 millacandela mcd/lux/m2
Color Identifier: **Red**

**Level 2**
**Maintenance**
Measurement Range: 300-499 mcd/lux/m2
Color Identifier: **Yellow**

**Level 3**
**Good**
Measurement Range: 500-899 mcd/lux/m2
Color Identifier: **Green**

**Level 4**
**Excellent**
Measurement Range: >900 mcd/lux/m2
Color Identifier: **Blue**

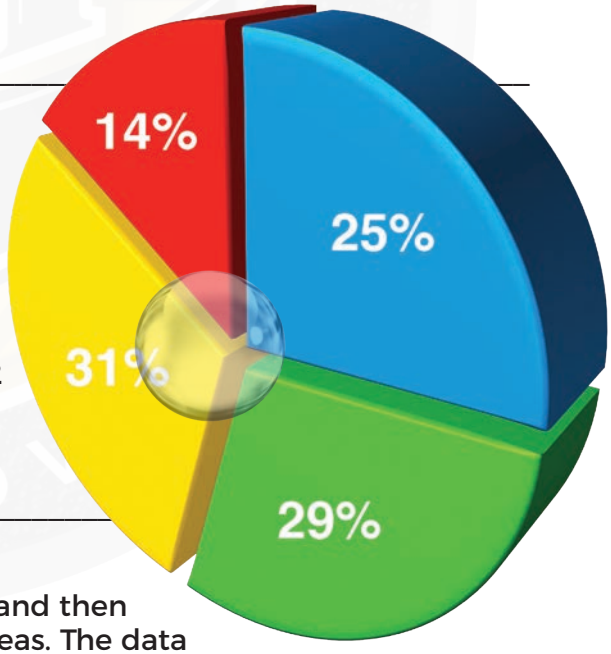
**Candela [kan-dee-luh]**
A basic unit of luminous intensity of light-emitting diodes is a candela. A Millacandela (mcd), is one thousandths of a candela. Simplified, one candela is the brightness of a candle held one foot from your face.




## Results

**Assessment results segmentation**

- Level 1 — 14 percent — **Below preferred minimum**
- Level 2 — 31 percent — **Maintenance**
- Level 3 — 29 percent — **Good**
- Level 4 — 25 percent — **Excellent**




Overall, the average reading throughout the airfield was an impressive (by roadway standards) 621 mcd/lux/m2

## Recommendations

JAA immediately put the data from the assessment to use. The crew targeted the level 1 (below minimum) areas first and then developed a maintenance plan for the other segmented areas. The data enabled them to be more efficient with their resources and materials. The discussed action plan moving forward is having two additional full assessments; one in six months and one 12 months to establish a trend pattern. After the three initial assessments, JAA could go to an annual full assessment with interim assessment utilizing the handheld SM2T. The data from the trends study will assist JAA in saving money and other resources while ensuring and improving overall airfield safety. The interim assessments would provide for both contracted and internal marking maintenance quality assurance.

The overall financial savings that JAA is going to accrue in using this study is substantial, but more importantly the study ensures safety of the millions of pilots, passengers and crew members that use this airfield annually. A single incident as a result of over-maintenance or under-maintenance would be a far greater cost than that of an annual or semi-annual assessment.

## Retroreflectivity Assessment Savings

For near absolute assurance of compliance and safety without comprehensive assessment would likely require the entire airfield markings to be reapplied annually. But with comprehensive assessment, the underperforming markings can be segregated and placed in a maintenance program. In this case study, even with JAA's high standards, only 45% of the total airfield markings were the identified as needing maintenance. Saving the airport 55% in marking cost while insuring near absolute compliance and safety.  At an average contracted price of $2.56* per square foot for reapplication, the savings equates to over $682,880.

| Total Airfield Markings | | Contract Price | | Total Cost |
|---|---|---|---|---|
| 485,000 sq/ft | + | $2.56 sq/ft | = | $1,241,600 |

| Identified Airfield Markings | | Contract Price | | Total Cost |
|---|---|---|---|---|
| 218,250 sq/ft | + | $2.56 sq/ft | = | $558,720 |

**Estimated Savings**

**55% SAVINGS**

**$682,880 - 55% Savings**

**SAVINGS of $682,880**

**Average of most recent bid results for contract application of TT-P-1952 D Type 2 Paint with TT-B-1325 Type 3 Beads on a Large Hub Airport in southeastern US.  No matter the contracted or inhouse costs the estimated savings remain at 55%.*

** Material costs vary depending upon quantity, region, and contract negotiation.*

The findings of this case study indicate that initial and annual comprehensive assessment would be very beneficial for both savings and safety. In order to achieve trending data, PPP recommends three consecutive, full assessments in six-month increments. Following that, an annual full assessment with periodic handheld and visual assessment throughout the year should be completed.


> "The methods being developed as a result of this case study allows me to focus on the poor areas, and look a year or so out from a maintenance planning perspective. In the past we have applied new paint across the entire airfield, or in areas we suspected poor markings, which led to buildup and then removal. We were painting the runway centerlines four times per year right over the rubber build up, now we are going to try only 1-2 times per year with cleanings in between, especially after seeing how the cleaning effected the retro-reflectivity."
>
> *Patrick Spakausky,*
> *Airside Operations Manager JAA*

## About the LLG-7 data from Jacksonville International Airport

**2,632,959 valid scans**
The LLG7 scans 400 sweeps per second. The firmware identifies measurements that are valid primarily by way of the minimum level set by operator. These valid scans then are used to create the records.

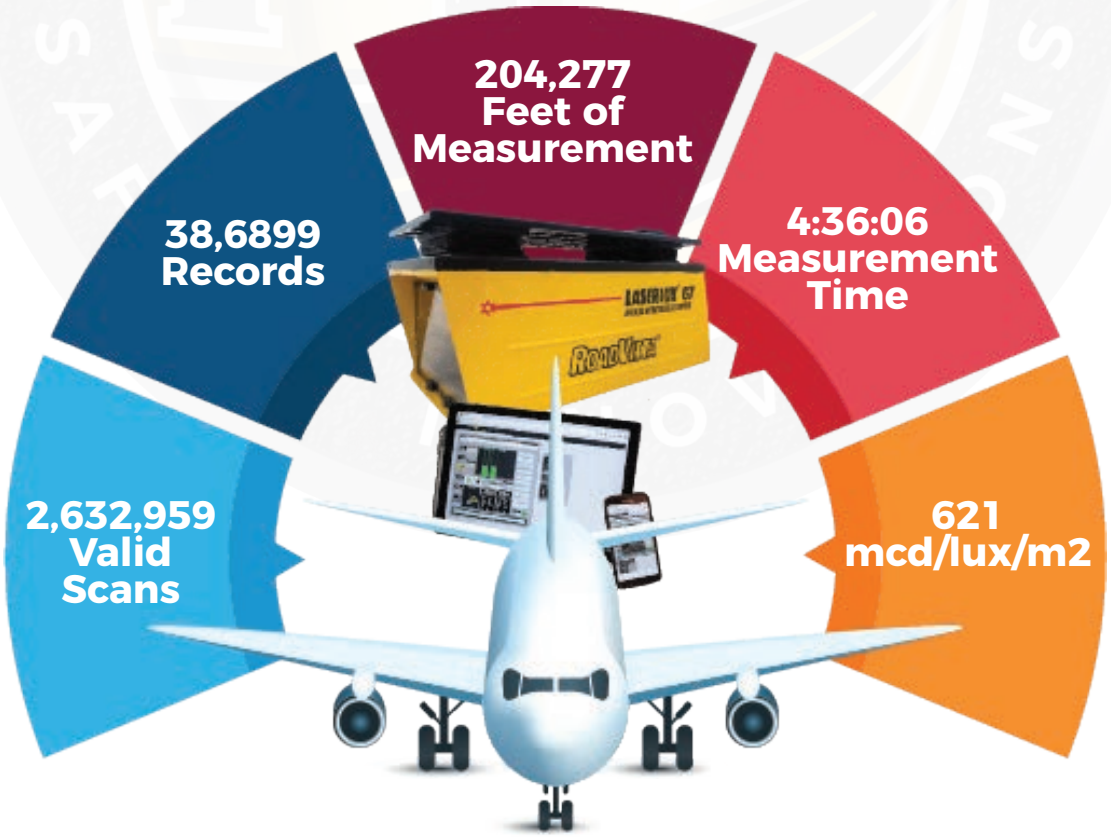
The LLG7 is equipped with laser technology that can measure, record and calculate from 25 to 8000 mcd/lux/m2.

**38,689 records**
LLG7 creates records which are groupings of the valid scans averaged over a distance set by the operator. In this case the average was set for every 5.28 feet.

**204,277 feet of measurement**
The LLG7 is equipped with advanced GPS technology that most often provides sub-meter accuracy. In such, it provides distance measured and the longitudinal/latitudinal coordinates of each calculated Record. In this case it measured nearly 39 miles of line.

**4:36:06 measurement time**
The LLG7 provides accurate, continuous readings in excess of 100 mph. This reduces needed down time of the airfield sections' assessments. In this case nearly the entire airfield was measured in about 4.5 hrs.

The LLG7 provides a .KML file that overlays a detailed visual report on the airfield through the use of Google Earth which allows the airfield operations staff to identify sections in need of maintenance and with periodic assessment provides for trending.



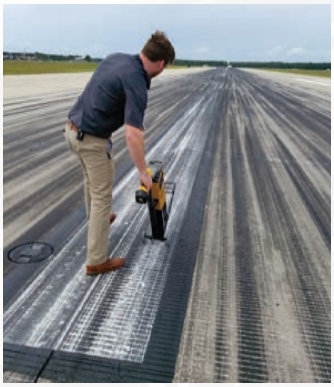
## Other Findings

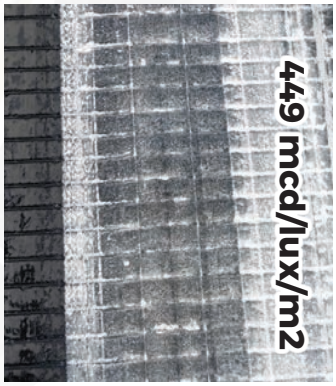
**Mobile to handheld comparison**
One additional objective of the case study was to compare the retroreflectivity assessment readings from the handheld retroreflectometer to the readings from the mobile retroreflectometer. Three areas on the airfield were measured by both unit types. The average variance between the instruments of the assessed areas was approximately 12 percent. This variance was not outside of expectations as the mobile retroreflectometer provides far more comprehensive data and a better sampling of the markings overall retroreflectivity than that of the handheld instrument.

**Handheld VS Mobile**

| Data | Mobile LLG7 | Handheld (SM2T) | Comp |
|---|---|---|---|
| Number of Records | 1,745 | 169 | 10X More |
| Number of Valid Scans | 123,411 | 169 | 730X More |
| Distance | 10,050 | 10,050 | |
| Feet Per Record | 17 | 1681 | 11X Closer |
| Time | 0:07:18 | 1:23:00 | 11X Faster |
| Feet Per Minute | 3,876 | 294 | 13X Closer |
| Average Reading | 371 | 421 | 12% Variance |

**Rubber build-up and removal impact on retrorelectivity**
While assessing the runway centerline with the handheld retroreflectometer, a maintenance crew was hydroblasting the markings by hand in attempt to improve their visibility and friction coefficient. The team took this opportunity to measure the effects of this process on retroreflectivity.




There were initial readings of 72 mcd/lux/m2 when a total of six passes were made over a three-foot section at 30 seconds per pass at 4,000 psi. Measurements were recorded between passes and retroreflectivity increased with each pass. After the sixth pass the measurement was 449 mcd/lux/m2. It was determined that daytime contrast visibility was only slightly improved. However, as the film of the rubber was removed for the glass surface of the beads, the coating's pigment sealed under the bead became increasingly visible through retroreflectivity even though the visual contrast had limited improvement; demonstrating that retroreflectivity under these conditions can improve or exist when daytime contrast does not.

Upon the team's visual inspection, issues with bead coverage and embedment of beads in the existing markings were discovered. Using a handheld smart phone with a camera, the

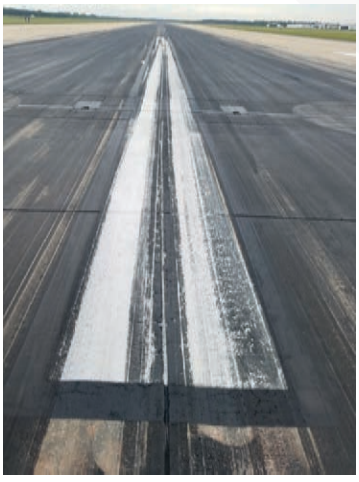
team photographed the line with flash. This simple process exposed the fact that beads were concentrated in the center and very few were on the edges, thus reducing the markings' retroreflective width. It was determined that the maintenance crew had been using a standard architectural tip when striping; a common mistake made by pavement marking professions, thus feathering the edges, reducing the paint's thickness and ability to hold beads in this area. The team also took several macro photos of the markings and the beads to investigate bead embedment. These photos exposed the fact that many of the beads had become detached and therefore, reducing the markings' retroreflectivity. It was discovered that the paint's foundational resin was not adequate for bead adhesion. Both issues were immediately corrected via a proper tip and new paint that was ordered for future applications.

## Retroreflectivity assessment instrument use observations:

**Mobile retroreflectometer assessment** was advantageous because it provided a greater level of personal safety, allowed for a comprehensive assessment in a short amount of time, recorded multi-level ratings, provided mapping capability, and allowed for data control. The disadvantages for utilizing the mobile retroreflectometer were that it is not the best instrument for lateral markings and no visual inspection is completed when utilizing this method.

**Handheld retroreflectometer assessment** is a great instrument for periodic maintenance assessment and contractor accountability assessment. It is best utilized for the following markings: Runway Designators, Runway Boundary/Hold Short Lines that are less than 200 feet long, Intermediate Hold Short Lines that are less than 200 feet long, Movement Boundary Lines that are less than 200 feet long, Hashmarks Lines (if required), Blast Pad Lines (optional). Advantages to utilizing the handheld retroreflectometer for retroreflectivity assessment include visual assessment ability, numerical assessment, the ability to measure both longitudinal and lateral markings, day or night assessment, pass/fail capability, and mapping capability. The disadvantages include that it is time consuming, not comprehensive, and isn't as advantageous for personal safety as the mobile retroreflectometer. "Use of the handheld retroreflectometer was a struggle for some areas and we had a desire to maintain markings on the entire airfield,'" said Patrick Spakausky.

**Visual assessment** of markings can be completed often and provides for unique needs and concerns. An advantage to visual assessing markings is that you can see the bead embedment which is very beneficial for both monetary savings and for ensuring safety. It would be ideal to track trending data. To achieve trending data it is recommended that three consecutive visual inspections be completed for both bead embedment and bead disbursement as well as to check the condition and adhesion of the paint. Unfortunately, the disadvantages of visual assessment outweigh the advantage. Visual assessment is subjective since there is not a numerical assessment, it is time consuming, it requires inspection to be done at night and it is a great risk to personal safety.



# Update: 2018-19 Follow Up Assessment

**Purpose**
Continuing PPP's commitment to improving transportation safety, in late 2018, we once again partnered in a follow up assessment.

There were three goals of the follow up assessment.

- Assist airfield management in creating a predictive maintenance process.
- Quality assurance of the airfield's marking crew.
- Test the newest LLG7-A mobile retroreflectometer features.

The LLG7-A's new features included Retroreflectivity Deviation detection, Night-Time Color evaluation and improved data segmentation.

**Parallels**
Same airfield and airfield markings were assessed. Used laser based LLG7 mobile retroreflectometer. Assessment completed at approximate same time of year. Airfield Maintenance vehicle used.

**Changes**
Applied December, 2018 changes in AC 150/5370-10H to evaluate assessment. Utilized new hardware, firmware and software features of the LLG7-A. Speed was reduced and average distances were increased. Did not measure smaller transverse lines. Did not use the handheld retroreflectometer. Did not preplan assessment route.

**2,775,722 valid scans**
Valid scans are used to create the records. This is a slight increase in valid scans over the 2017 assessment and is mostly the result of a slower assessment speed.

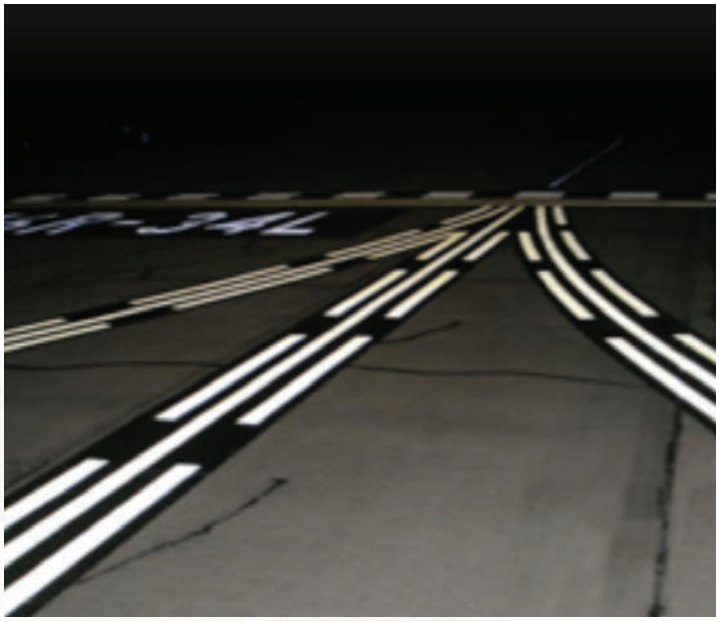
**10,490 records**
Records are the averaged segments of the valid scans. This is a reduction from the 2017 assessment primarily due to increasing the average segments from 5lf to 10lf. Also, a lesser number of markings were assessed in 2018. Slower speeds, and lacking a preplanned route decreased our assessment efficiency and distance within the allotted time.

**100,490 feet of measurement**
The LLG7's advanced GPS technology provides excellent visual mapping of the assessment. But we have found that approximate distance is easiest calculated by multiplying the number of records by the set segment distance.

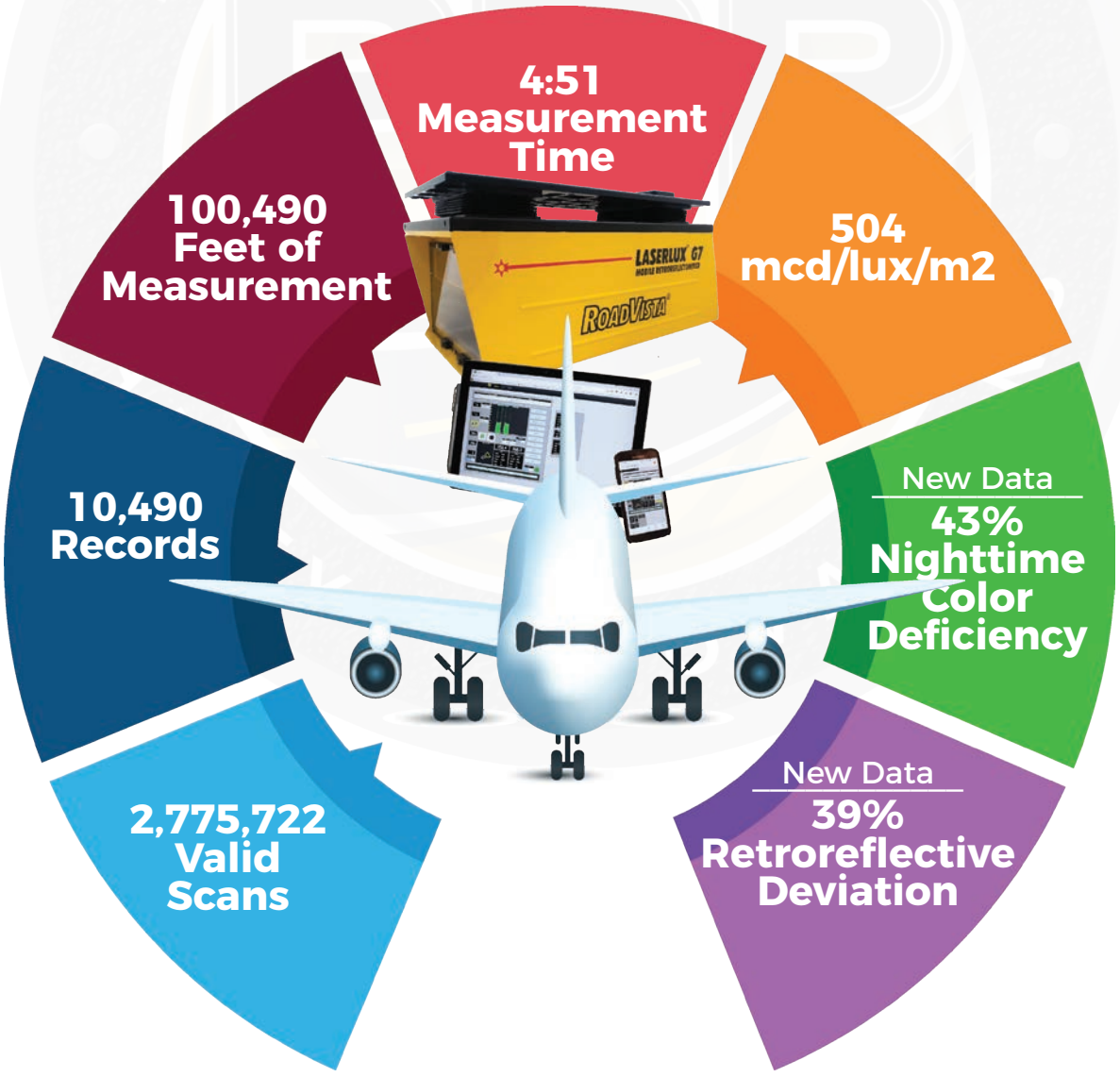
**4:51 measurement time**
The measurement time is near identical to that of the 2017 assessment. JAX allows 4 hours of assessment time or other maintenance for each runway once a week. With the LLG7 a full mobile assessment was completed in near half the time. This allows the remaining time for hand-held assessments of smaller lateral lines not easily measured by a mobile unit.

## NEW Data

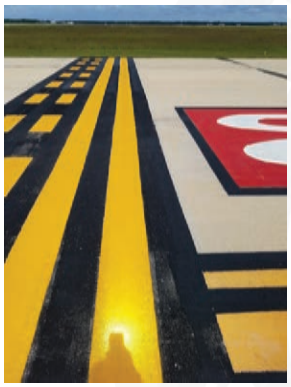
**39% Retroreflective Deviation**
For the 2018 assessment, improvements were made in hardware, firmware and software of the LLG7-A (Airfield) that provide the ability to identify retroreflective deviation. The FAA's AC 150/5370-10H Section 620-3.8 provide limits in which the marking's retroreflectivity can deviate. This deviation causes a visually distorted marking when viewed at night, which could interfere with its visibility and comprehension. On new markings, retroreflective deviation is most often caused by improper distribution of glass beads and/or the marking material. Older marking's retroreflective deviation is most often caused due to wear or foreign bodies such as rubber deposits on the surface of the marking. Using its high-speed laser based scanning, the LLG7-A is able to detect these deviations in both lateral (transverse) and longitudinal directions. When the data of the LLG7-A is processed it rates or scores the level of deviation it detected. The 2018 assessment only found 6% of the markings fell below the FAA minimum requirements, but found more than 30% of the markings with notable retroreflective deviation.



**43% Nighttime Color Deficiency**
The LLG7-A used in the assessment was equipped with additional hardware for night-time color assessment. It is important to understand that the color of a marking can vary greatly from day to night. For example, a white marking may appear grey or a yellow marking may even appear white. Color is effected by the type, quality, and application of the marking materials and glass beads. Although, at the date of this report, the FAA has not established a night-time color requirement, assessing and maintaining night-time or retroreflected color is crucial to the safety of the airfield. Night-time color is evaluated using ASTM D6628.





**Author:** Greg Driskell

TRANSPORTATION PPP SAFETY INNOVATIONS

# SAFE, SMART, SIMPLE SOLUTIONS

**SaferRoads™ RoadVista® AlertBrands™ Guideline™**

**Corporate Office:**
9957 Moorings Drive, Suite 301
Jacksonville, FL 32257

888.717.7771 • WWW.PPPCATALOG.COM