PAVEMENT EDGE LIGHT SAFETY SYSTEM PELSS

A VISUAL ENHANCEMENT TO AIRFIELD LIGHTING

By:
Scott Stauffer
Luminaerospace, LLC
sstauffer@luminaerospace.com

Traditional Taxiway Lighting

Point Reference

- Single point of illumination, 60 years +
- Aesthetically disturbing, "eye piercing" appearance
- May appear as a "sea" of random blue lights
- Inadequate visual cues

Point Source Lighting - Confusing

- Excessive quantity needed for complex intersections
- Visual interpretation is challenging

Pavement Edge Light Safety System

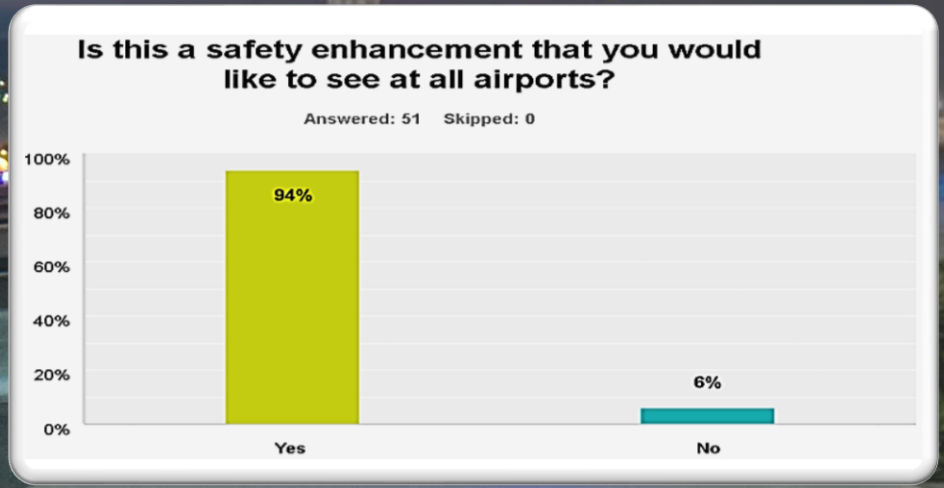
Lineal Reference – Illuminating the Path to Safety

- Improved boundary recognition
  - Illuminated horizontal linear bar
- Provides information related to BOTH
  - Location of the pavement edge
  - Orientation of the pavement edge

Pavement Edge Light Safety System

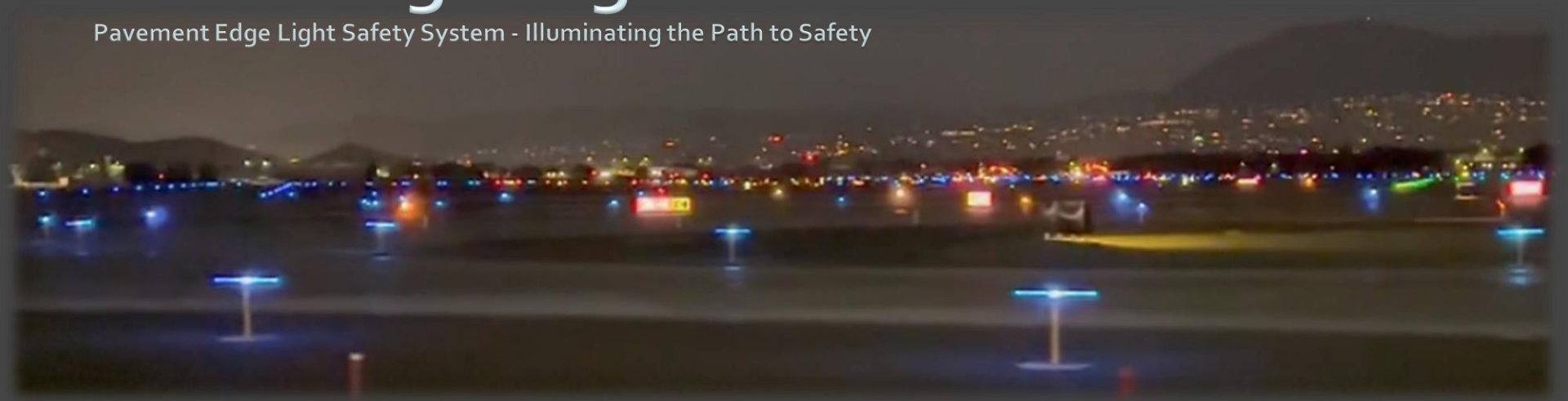
Lineal Reference – Illuminating the Path to Safety

- A Pilot developed, patented solution
- Simply add a visual directional cue
- Pilots yearn for these improvements



PELSS Lighting Enhancement

Pavement Edge Light Safety System - Illuminating the Path to Safety



- Improved situational awareness even at maximum allowable spacing
- "When there is no ambient lighting, this is all we've got"
  - Army Chief Warrant Officer and Apache Pilot, Michael Murray

PELSS Longevity

Pavement Edge Light Safety System - Illuminating the Path to Safety

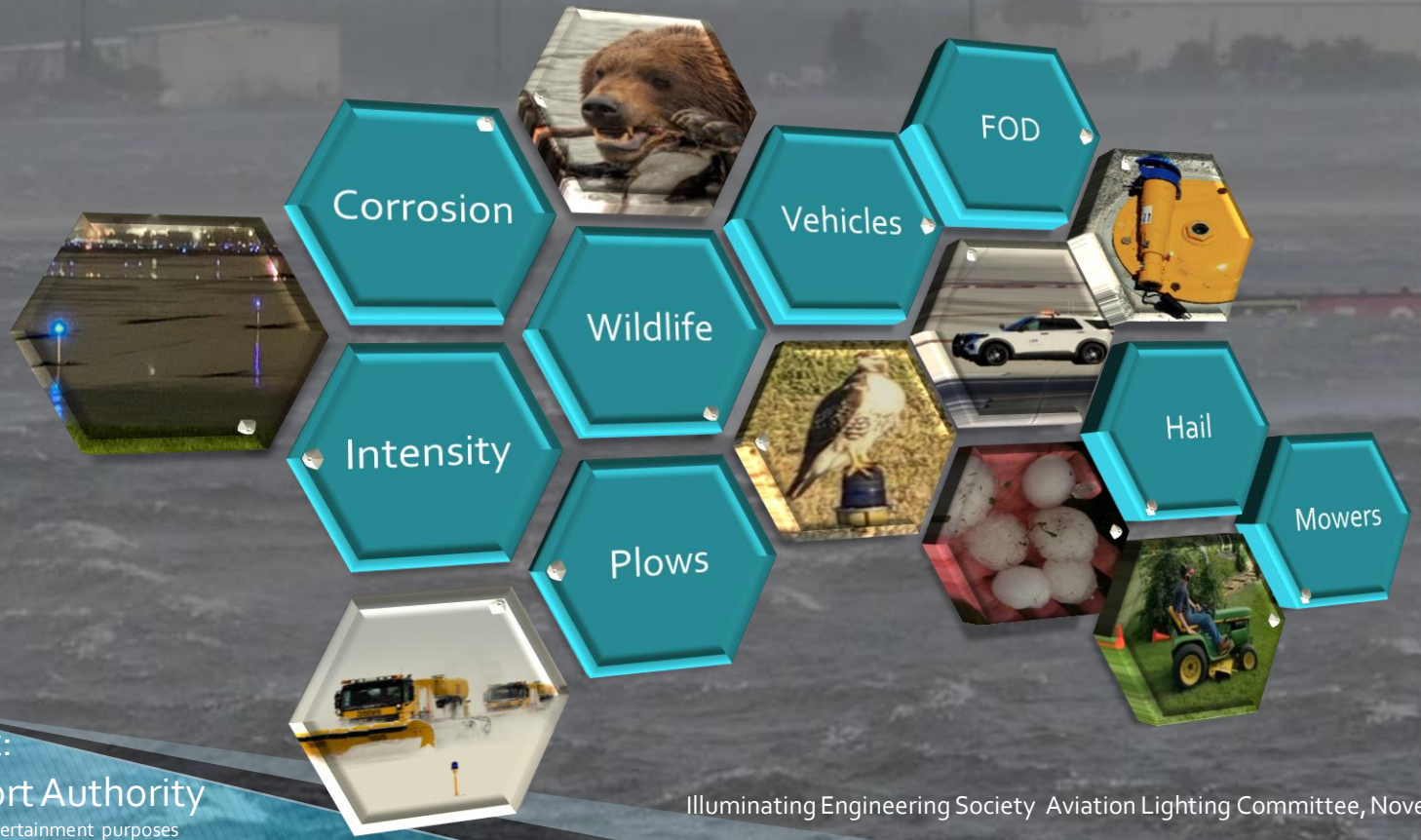
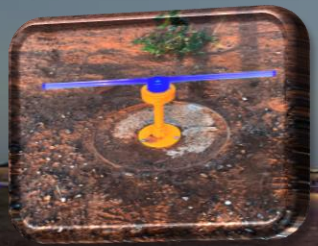


Photo Credit:
Naples Airport Authority
"Shark fin" added for entertainment purposes

Linear Options

Lineal Reference – Illuminating the Path to Safety



Replacement Lenses
(fits several fixture types)

FAA Certified Fixture (6.6A CC available soon)

240V Constant Voltage
(available now, future certification)

Solar Linear Projection (no FAA certification, license pending)

Arrays of Segmented Point Source Lighting
(UK CAA Compliant, invalid license)

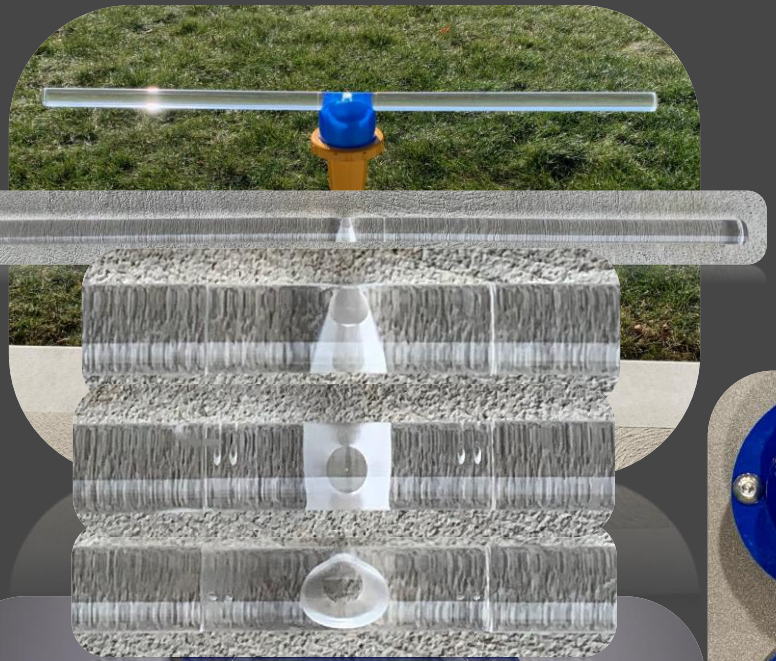
Battery Powered Safety Cone
(Solar under development)

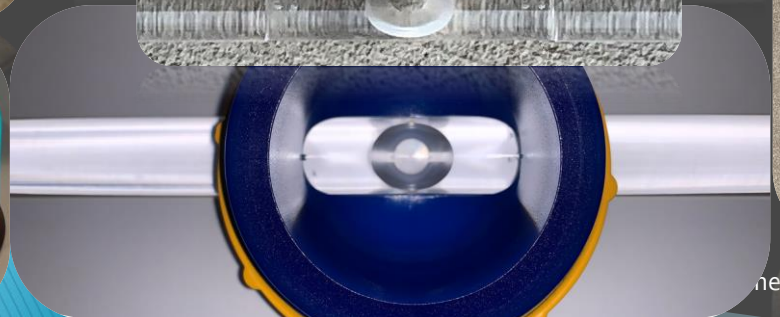
Luminescent Panel
(Elevated and Surface Mount in development)

Replacement Lens

- Fits traditional fixture over optic and LED
- Specialty light diffusing acrylic
  - Molded acrylic hub with colorant
  - Extruded clear linear rod
  - Permanent adhesive bond of rod and hub
  - Non-yellow guarantee, 15 years
  - Hail resistant, 11 times stronger than glass
- Field retrofit voids FAA Certification

Replacement Lens





Replacement Lens

- Assembly is simple… seeing is believing (click below to view install videos)
  - Rod/hubs with split retaining ring are shipped assembled
  - Existing retaining rings may be reused if assembled on site

PELSS Progress

- 2008 - 2010 FAA Engineering Division contact, Utility Patents secured
- 2011-2013 Demonstration - Cleveland
- 2014-2018 Product Development / Small Trials
- 2019-2022 Lens Replacement introductory sales
- 2022 FAA Operations Division authorizes two Part 139 test sites
- 2023 Full Airport Installation, 100 linear fixtures
  - (Safe //Secure//Click leads to really cool drone video of full linear install)
- Next tasks
  - FAA Certification, Contract Manufacturing, Marketing
  - Introduce new linear products
    - Safety Cones, Highway Guardrail, Street Curb

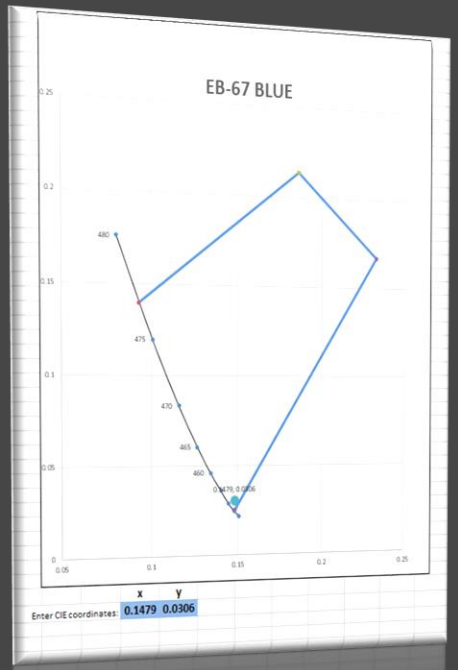
Certification

- Standard L-861T(L)
  - Alleviates "Sole Source" for AIP funding
  - Offered as any other taxiway light bid on the market
  - Linear shapes are acceptable under existing FAA guidelines
  - https://www.dropbox.com/s/srugc32540kpr8q/Intertek%20Engineering%20Review%20Luminaerospace.pdf?dl=0
  - Airport Lighting Equipment Certification Program (ALECP)
  - Will be listed in Advisory Circular 150/5345-53D addendum
  - Advisory Circular 150/5345-46E (F draft)
  - Engineering Brief 67

Certification

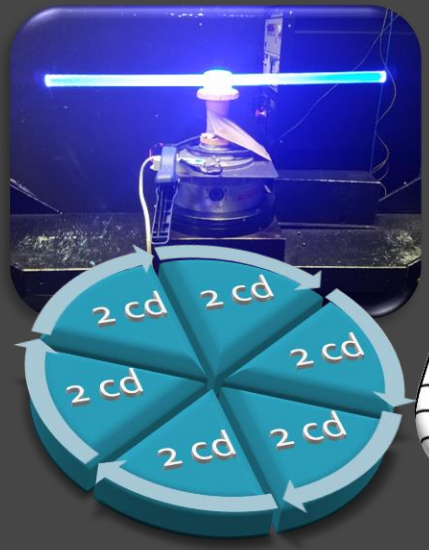
- Standard L-861T(L)
  - Alleviates "Sole Source" for AIP funding
  - Offered as any other taxiway light bid on the market
  - Linear shapes are acceptable under existing FAA guidelines
  - https://www.dropbox.com/s/srugc32540kpr8q/Intertek%20Engineering%20Review%20Luminaerospace.pdf?dl=0
  - Airport Lighting Equipment Certification Program (ALECP)
  - Will be listed in Advisory Circular 150/5345-53D addendum
  - Advisory Circular 150/5345-46E (F draft)
  - Engineering Brief 67

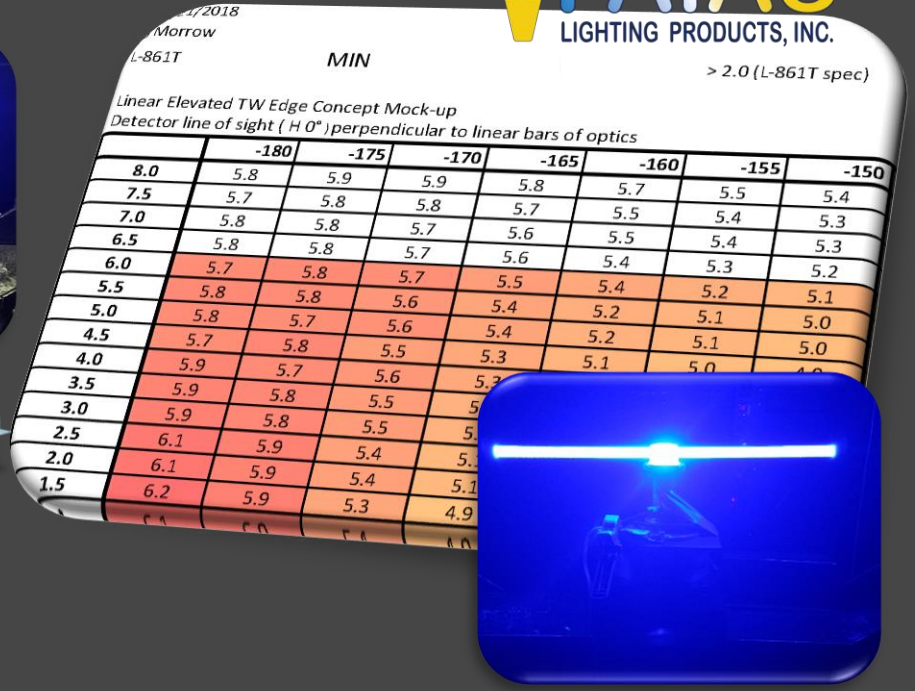
Specifications



L-861T Fabricated by

FAIAS LIGHTING PRODUCTS, INC.





/2018
Morrow
L-861T
MIN
> 2.0 (L-861T spec)

Linear Elevated TW Edge Concept Mock-up
Detector line of sight (H 0°) perpendicular to linear bars of optics

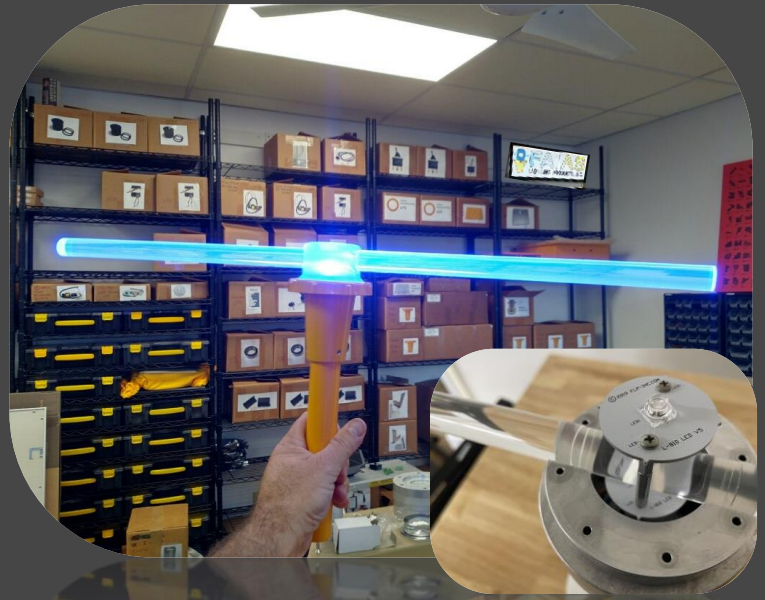
	-180	-175	-170	-165	-160	-155	-150
8.0	5.8	5.9	5.9	5.8	5.7	5.5	5.4
7.5	5.7	5.8	5.8	5.7	5.5	5.4	5.3
7.0	5.8	5.8	5.7	5.6	5.5	5.4	5.3
6.5	5.8	5.8	5.7	5.6	5.4	5.3	5.2
6.0	5.7	5.8	5.7	5.5	5.4	5.2	5.1
5.5	5.8	5.8	5.6	5.4	5.2	5.1	5.0
5.0	5.8	5.7	5.6	5.4	5.2	5.1	5.0
4.5	5.7	5.8	5.5	5.3	5.1	5.0	
4.0	5.9	5.7	5.6	5.3			
3.5	5.9	5.8	5.5	5			
3.0	5.9	5.8	5.5	5			
2.5	6.1	5.9	5.4	5.			
2.0	6.1	5.9	5.4	5.1			
1.5	6.2	5.9	5.3	4.9			

Industry leaders

- Trial, demonstration or purchase
  - KCLE, Cleveland, Ohio
  - CYVR, Vancouver, BC
  - FA54 Coral Creek, Florida
  - KBCT Boca Raton, Florida
  - KMRY Monterey, California
  - KSGR Sugarland, Texas
  - KSTS, Sonoma, California
  - KSUA, Stuart, Florida
  - KTEX, Telluride, Colorado
  - KVRB Vero Beach, Florida
  - LFPG Paris, France
  - KMIA Miami, Florida
  - KPDX Portland, Oregon
  - KRKD Rockland, Maine (Part 139 FAA evaluation)
  - KRNO Reno, Nevada; (Part 139 FAA evaluation)
  - CYST, St. Theresa Point, Manitoba
  - F82, Lubbock, Texas
  - MORE, IESALC Members

Strategic Partners

- Team of Experienced Industry Vendors
  - HyperSPEAR – Electronics
  - FAIAS - Hardware



FAIAS LIGHTING PRODUCTS, INC.

Maintenance

- Clean using a mild soap and water solution
  - Never use a solution containing more than 50% isopropyl alcohol.
  - 100% isopropyl alcohol is not compatible with acrylics.
- Inspect for Crazing
  - If seen, investigate use of incompatible cleaner (do not use isopropyl alcohol)
- Mow parallel to the lens orientation
  - Consider Airfield Mats to prevent tall grass

Distribution Strategy

- Estimated Linear Fixture Quantity
  - 7000 AIRPORTS in patented regions
    - Small Airport (100 fixtures)
    - Medium Airport (500 fixtures)
    - Large Airport (4000 fixtures)
- Near term sales – direct to airports
- Sales shift – direct to airfield contractors
- Continue adding OEM's

Thank you!

- Luminaerospace "Member" Investors, founded in 2010
  - Most investors are pilots for US Air Carriers
- Mission Statement
  - Improve Airfield Ground Lighting Safety through deployment of elevated linear lighting
- Utility Patents with priority back to 2009
  - North America - US8,454,189 B2; US9,193,482 B2;
  - South America - BR 112013003760-1 B1
  - Asia - CN103262140 (B);
  - Europe - EP2606483 B1

www.luminaerospace.com

Frequently Asked Questions

- Does the FAA allow non-standard fixtures in FAA Part 139 Movement and Non-Movement Areas?

  - Since Certification was performed with an OEM lens, it can no longer be relied upon. Alternate documentation will be provided that confirms that Linear complies with all specifications. Until our complete linear fixture is Certified, Part 139 Airfield installs should be coordinated through your FAA Airfield Inspector on a case by case basis when there is a safety concern that may be addressed with linear lighting. 139 airports will conduct periodic visual inspections to verify equipment meets "Specifications".

- Will birds land on the rod?

  - Maybe, birds require a learned behavior to determine that a clear transparent obstacle is a solid before they will attempt to land on it. It will not attract additional birds to an airport as a food source would. Bird droppings from a narrow perch tend to land on the ground. We have yet to determine if the clear rod will prevent birds from landing on the central hub attachment point.

- Will snow removal or hail damage the rod? Do we have to mow around it?

  - The rods are extremely durable. Snow throwers, sweepers, small hail and stones will not break the rod. If struck by a vehicle, the existing frangible will break. Rubber "Airfield Mats" are commercially available upon request to assist with grass mowing.

Frequently Asked Questions

- Since the linear design intentionally prevents the piercing "burning my retina" effect, is it okay mix on the same taxiway if the brightness appears different?
  - Use your discretion. When LED's began replacing incandescent, the piercing effect resulted in an advisory to avoid mixing LED and incandescent on the same taxiway. Linear purposefully attempts to emulate the softer appearance of incandescent by adding light diffusing material to the central hub; It is recommended to use larger clusters of linear without single point sources (unless geometry requires it) in order to prevent the illusion that the amount of light differs. Linear shape recognition increases with higher steps of brightness, while single point LED at the highest step can create residual spots on the retina due to overstimulation of the photoreceptors. This is a balance while choosing the desired step to operate for a given condition.
- Is this as good as it gets?
  - No, with your feedback we will continually improve while soliciting more manufacturers to apply for listing in FAA Addendum 5345-53

Frequently Asked Questions

- Can these material survive extreme low temperatures in the arctic?

Yes, here is a response from the material resin engineer…. This was some testing we did for a large automotive customer, in automotive testing is very strict and precise and required.

In automotive it is typical to do thermocycling testing. Typical ranges are from -30 C to 80 C. Relative humidity also cycled, don't know the end points. Here's some data from X customer package for 8N resin… unnotched no change, notched small change. In the testing I've seen 8N 23 performs just like 8N

J. Property	L. Standard	M. Units	N. Min # of lots required	O. # of lots tested	P. Mean Value MV	Q. Standard Deviation			R. Lowest Observed Value	S. Highest Observed Value	T. GM Spec. Value	U. Certifiable Test Value		V. Test Frequency
						σ	MV -3σ	MV +3σ				Min	Max	
Unnotched Charpy Impact Strength at 22°C	ISO 179/ 1eU, Specimen 80 X 10 X 4 mm	kJ/m²	6	6	17.92	1.49	13.45	22.39	15	21		13.45	22.39	Annually
Unnotched Charpy Impact Strength at -30°C	ISO 179/ 1eU, Specimen 80 X 10 X 4 mm	kJ/m²	6	6	18.8	1.44	14.48	23.12	16	22		14.48	23.12	Annually
Notched Charpy Impact Strength at 22°C	ISO 179/ 1eA, Specimen Machined V-notch, r = 0.25 mm, 80 X 10 X 4 mm	kJ/m²	6	6	1.71	0.48	0.27	3.15	0.85	2.5		0.27	3.15	Initial Approval
Notched Charpy Impact Strength at -30°C	ISO 179/ 1eA, Specimen Machined V-notch, r = 0.25 mm, 80 X 10 X 4 mm	kJ/m²	6	6	1.21	0.38	0.07	2.35	0.65	2.1		0.07	2.35	Initial Approval