Federal Aviation Administration

Illuminating Engineering Society (IES) Government Contacts Sub-Committee Meeting

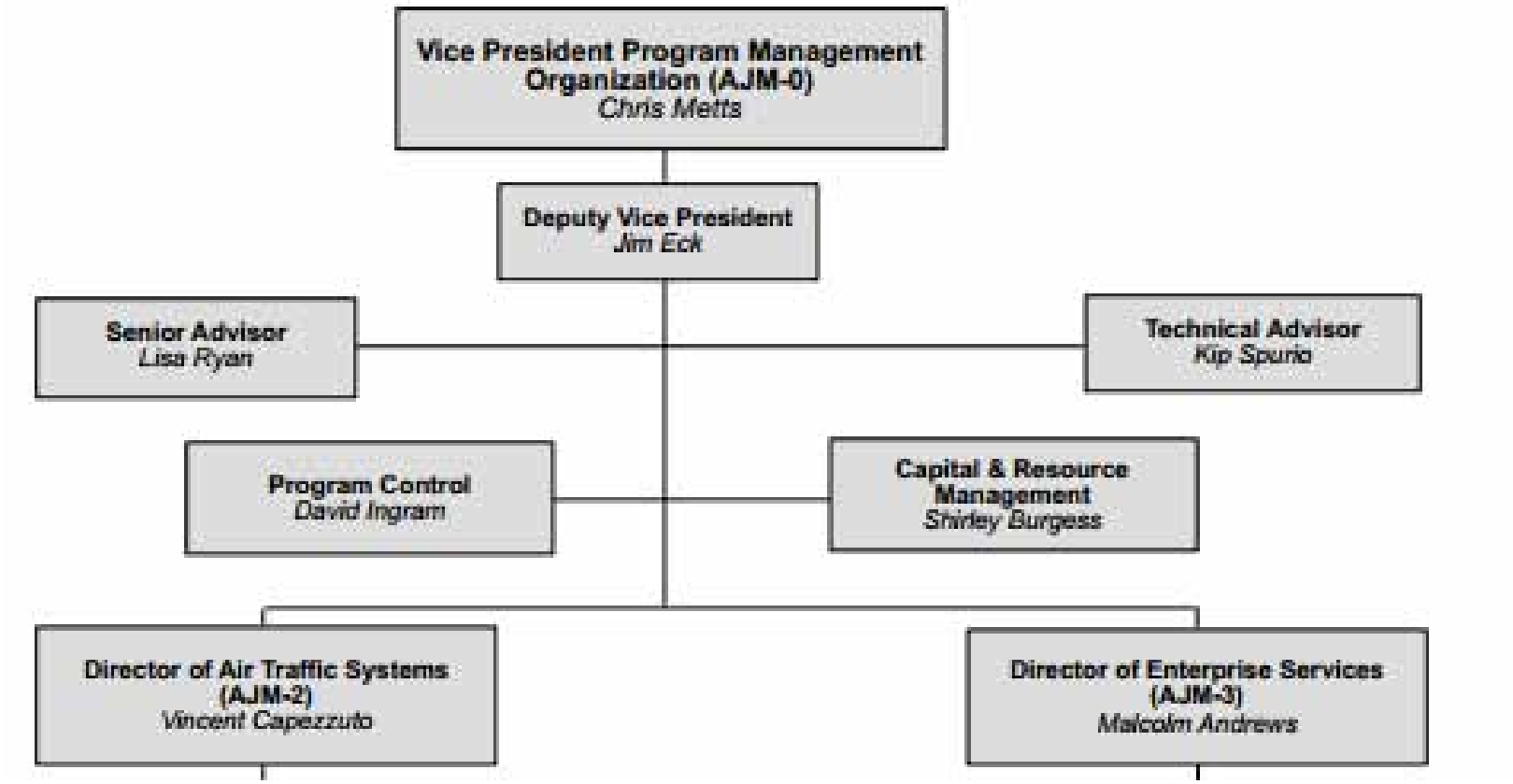
Navigation Programs,
Lighting Systems Sub-Team
AJM-3222

October 20, 2014

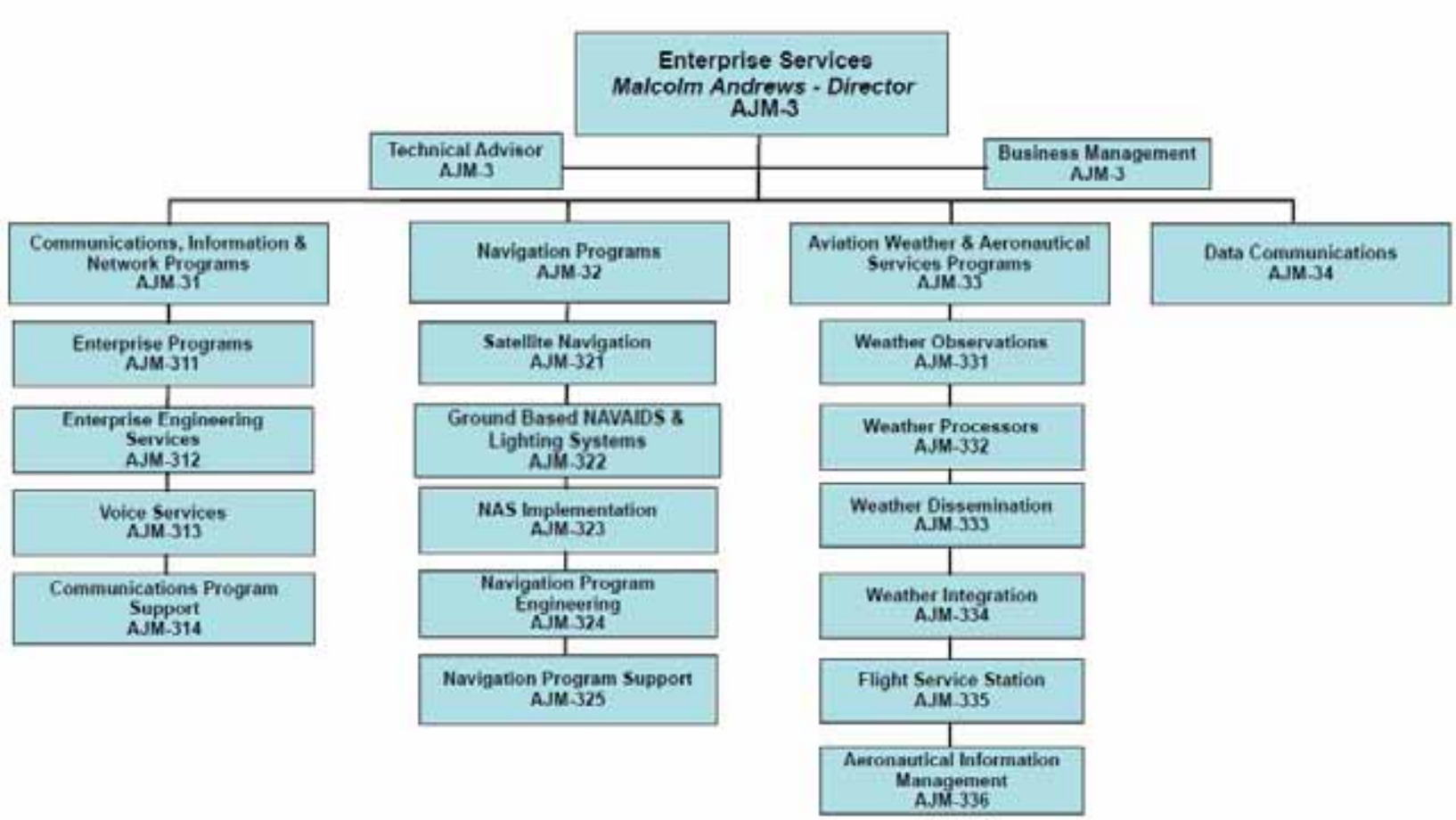
Overview

- Organizational Structure
- Future Navigation Strategy
- Advanced Lighting Concepts
- Active Projects
- Specification Updates
- Procurement Opportunities

Air Traffic Organization (ATO)



Enterprise Services



Ground Based NAVAIDS and Lighting Systems

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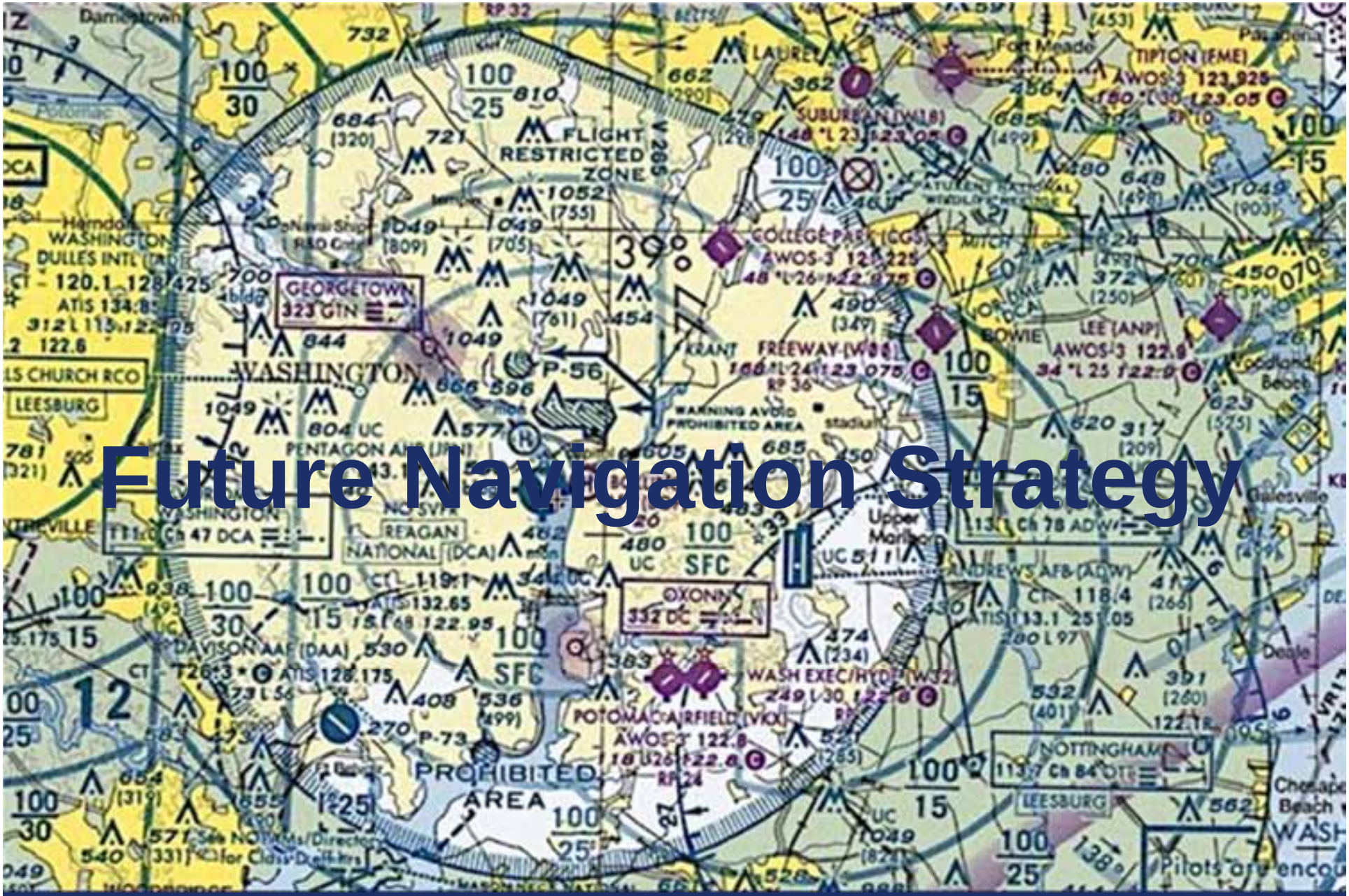
Lighting Systems and Ancillary Equipment

- Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR)
- High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2)
- Precision Approach Path Indicator (PAPI)
- Runway Visual Range (RVR)
- Runway End Identifier Lights (REILs)
- Radio Remote Control System (RRCS)
- Radio Remote Control Interface Unit (RRCIU)
- Replacement Lamp Monitoring System (RLMS)
- Lead-in Lights
- Semiflush Flashers & Steady Burners
- Low Impact Resistant (LIR) Structures
- Transformers
- Frangible Bolts
- Aiming Devices


Future Navigation Strategy

NAS Navigation Strategy

- The NAS Navigation Strategy provides information for the sustainment of current navigation services, the transition to performance-based navigation (PBN), and the delivery of the Next Generation Air Transportation System (NextGen) services.

- It addresses the planning and actions required through the 2025 - 2030 timeframe.

Navigation Programs Status

- Today's navigation programs support safe operations, but…

- Today's ground-based systems:
  - Rely on technologies that were originally fielded <1950s
  - Require use of fixed routes that cannot be dynamically adjusted to changing operational conditions

- Need to evolve ground-based systems and space-based systems together to fully realize future NAS/NextGen operational improvements

Navigation Program Evolution

- Today
  - NAS navigation services are based on a combination of ground-based and satellite-based services in all phases of flight
  - PBN capabilities have been initiated in the NAS

- Future
  - Navigation services will continue to be based on a combination of ground based and satellite based services in all phases of flight
    - The ground based navaids (GBN) infrastructure will be reduced
  - Navigation services will be primarily provided by satellite based systems

Non-precision Transition

(Final Approach)

2013	2020	2030
Current	**2020 (Transitional)**	**2030 (Future)**
VOR	VOR Minimum Operational Network (MON)	Limited VOR Infrastructure
Distance Measuring Equipment (DME	DME/DME with or without Inertial Reference Unit	DME/DME with or without Inertial Reference Unit
MALSR, ALSF-2 RVR, PAPI, REIL	**MALSR, ALSF-2 RVR, PAPI, REIL**	**Advanced Lighting Concepts (ALC)**

Precision Transition

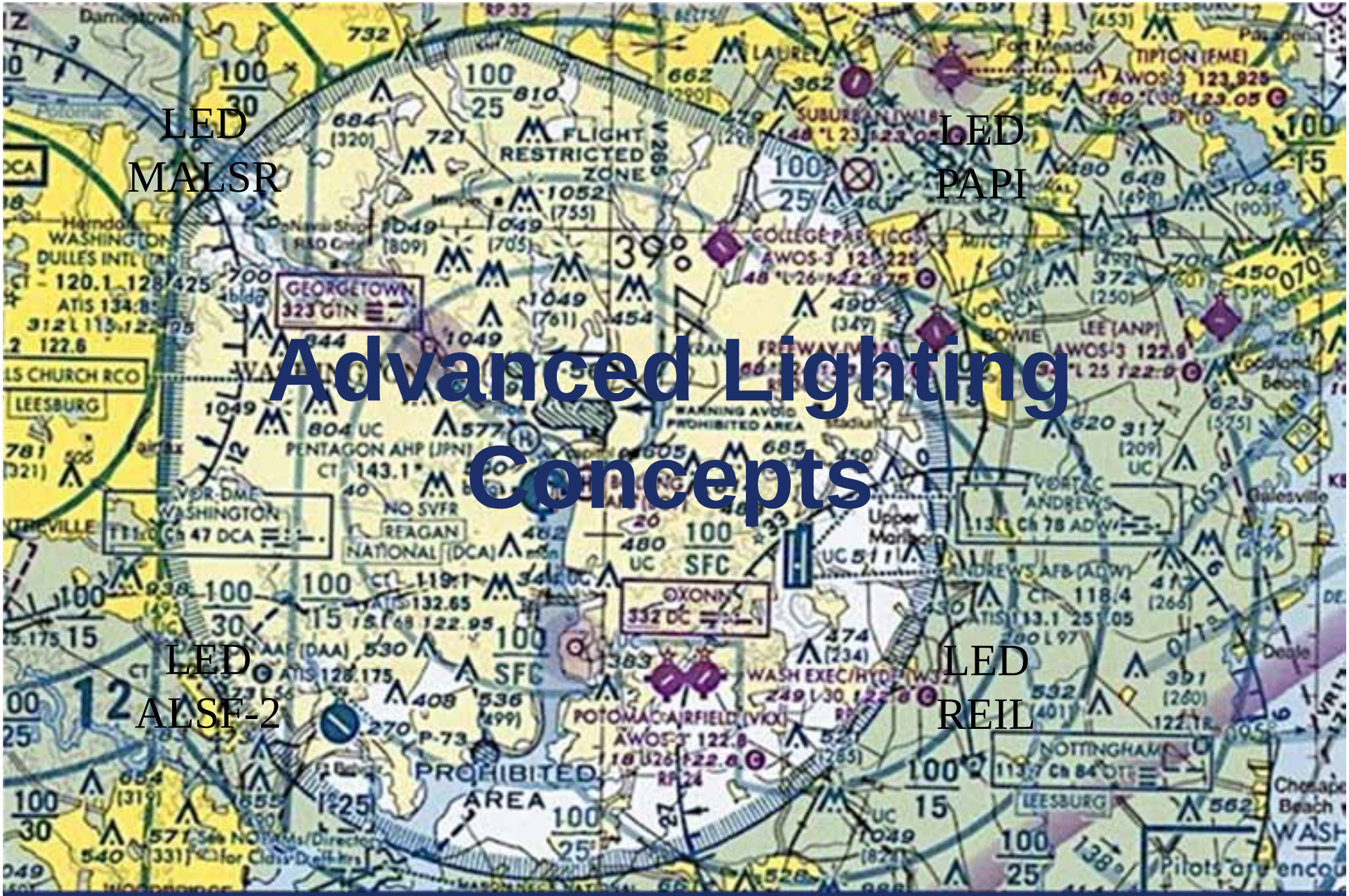
(Final Approach)

2013 — 2020 — 2030

2013	2020	2030
Current Instrument Landing System (ILS) Category I	**2020 (Transitional)** ILS Category I	**2030 (Future)** ILS Category I
ILS CAT II/III	ILS CAT II/III	ILS CAT II/III
MALSR, ALSF-2 RVR, PAPI, REIL	**MALSR, ALSF-2, RVR, PAPI, REIL**	**Advanced Lighting Concepts (ALC)**

Potential 2016 ILS reduction enabled by WAAS LPV deployment*

Contingent on 2016 GBAS Cat II/III Decision



Advanced Lighting Concepts

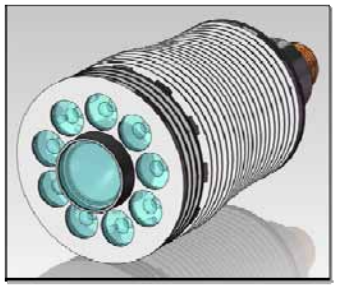
Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR)

Service Description

- The MALSR provides visual information on runway alignment, height perception, roll guidance, and horizontal references for Category (CAT) I precision approaches and Special Authorization CAT II Operations

Roadmap to the future

- Transition from current PAR-38 incandescent lamps to energy efficient LED technology
  - Developing alternative LED lamps that can use existing lamp fixtures to minimize cost of conversion
  - Establish a transition plan to replace incandescent lamps
  - Determining need to retain some infra-red emission to support enhanced flight vision systems (EFVS) and Night Vision Systems (NVS)
- Transition from current PAR-56 threshold lamps to LED technology
  - Rely on LED technology to improve reliability and maintainability and reduce ops costs



High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2)

Service Description

- The ALSF-2 provides visual information on runway alignment, height perception, roll guidance, and horizontal reference for all categories of precision approaches, primarily Category (CAT) II/III

Roadmap to the Future

- Evaluate potential for reducing footprint and number of lamps needed to support CAT II/III approaches
- Leverage lessons learned from the MALSR program to implement Light Emitting Diode (LED) in the ALSF-2 design to the extent possible

Precision Approach Path Indicator (PAPI)

Service Description

- PAPI provides visual approach slope information to pilots and enables them to make stabilized descent and approach clearances over obstructions
  - PAPI is used primarily to support Visual Flight Rules (VFR) operations

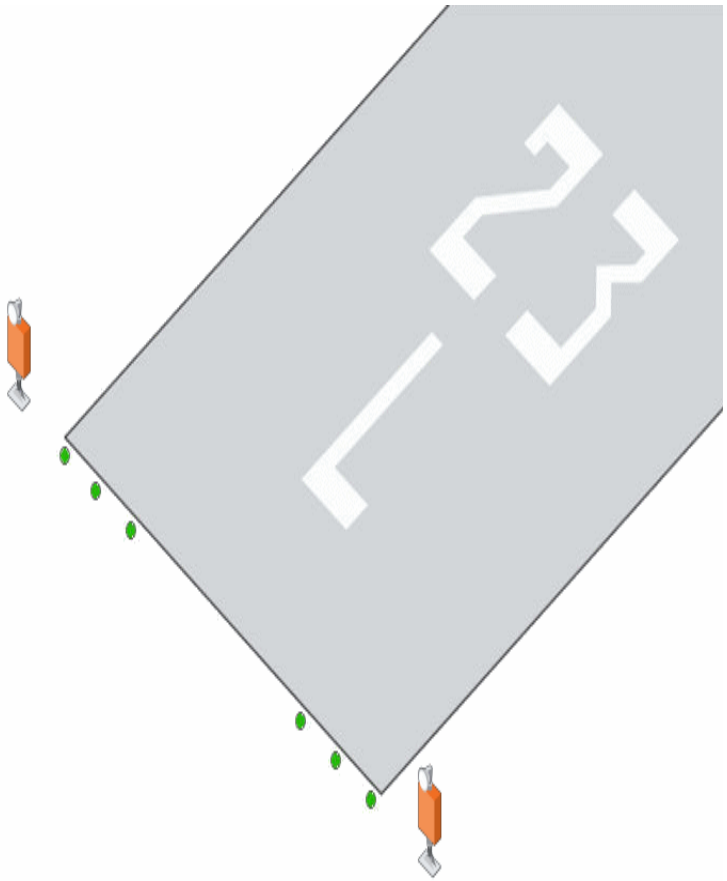
Roadmap to the future

- Insert LED technology into legacy lighting systems that addresses improving reliability and maintainability
  - ➢ Possible to reduce the lifecycle cost of Visual Glide Slope Indicator (VGSI) by at least 50 percent

Runway End Identifier Lights (REILs)

Service Description

- The REIL is a non-precision visual aid that provides rapid and positive identification of the approach end of a particular runway to the pilot.
- REILs are required for current and future NAS operations
- Approx. 400 REILS are beyond their 20 year life-cycle; over 200 REILs are >30 years old



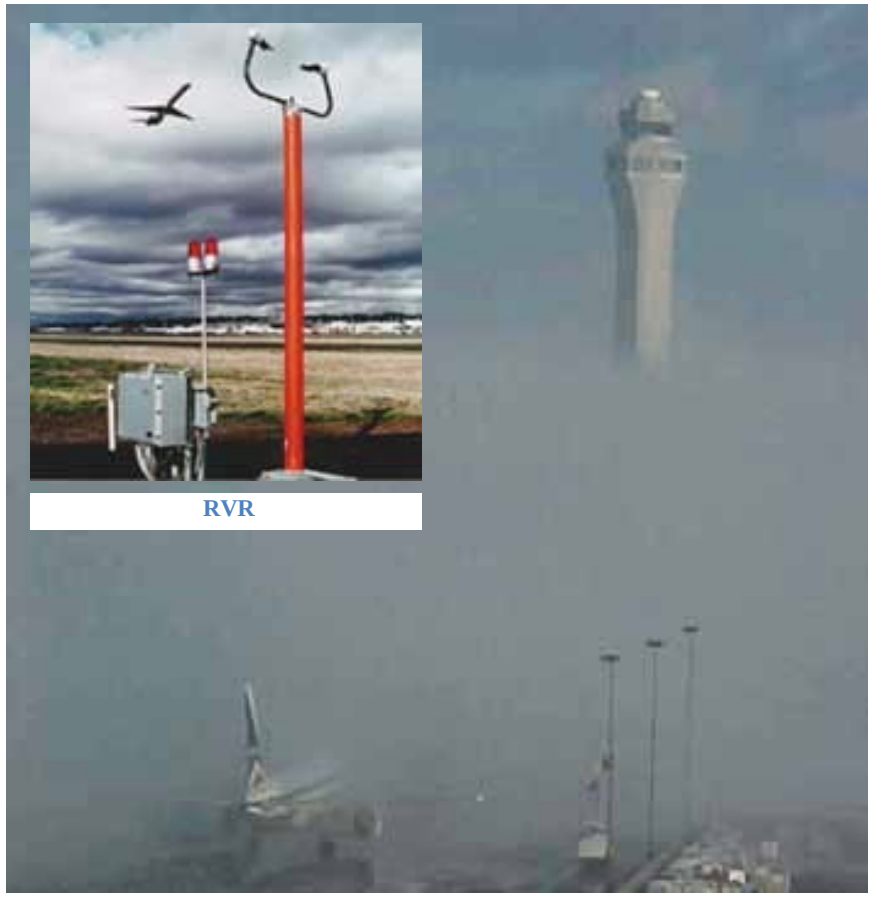
Roadmap to the future

- Transition from zenon flashtubes to LED Technology
- Insert LED technology into legacy lighting systems to improve reliability and maintainability
- Current program is replacing REILs to at a rate of ~10/year

Runway Visual Range (RVR)

Service Description

- Runway Visual Range (RVR) provides air traffic controllers with a measure of the distance a pilot can expect to see the runway
- RVR becomes critical when visibility is less than a mile
- RVR information is required for departure and Category (CAT) II, III, and many CAT I precision approaches

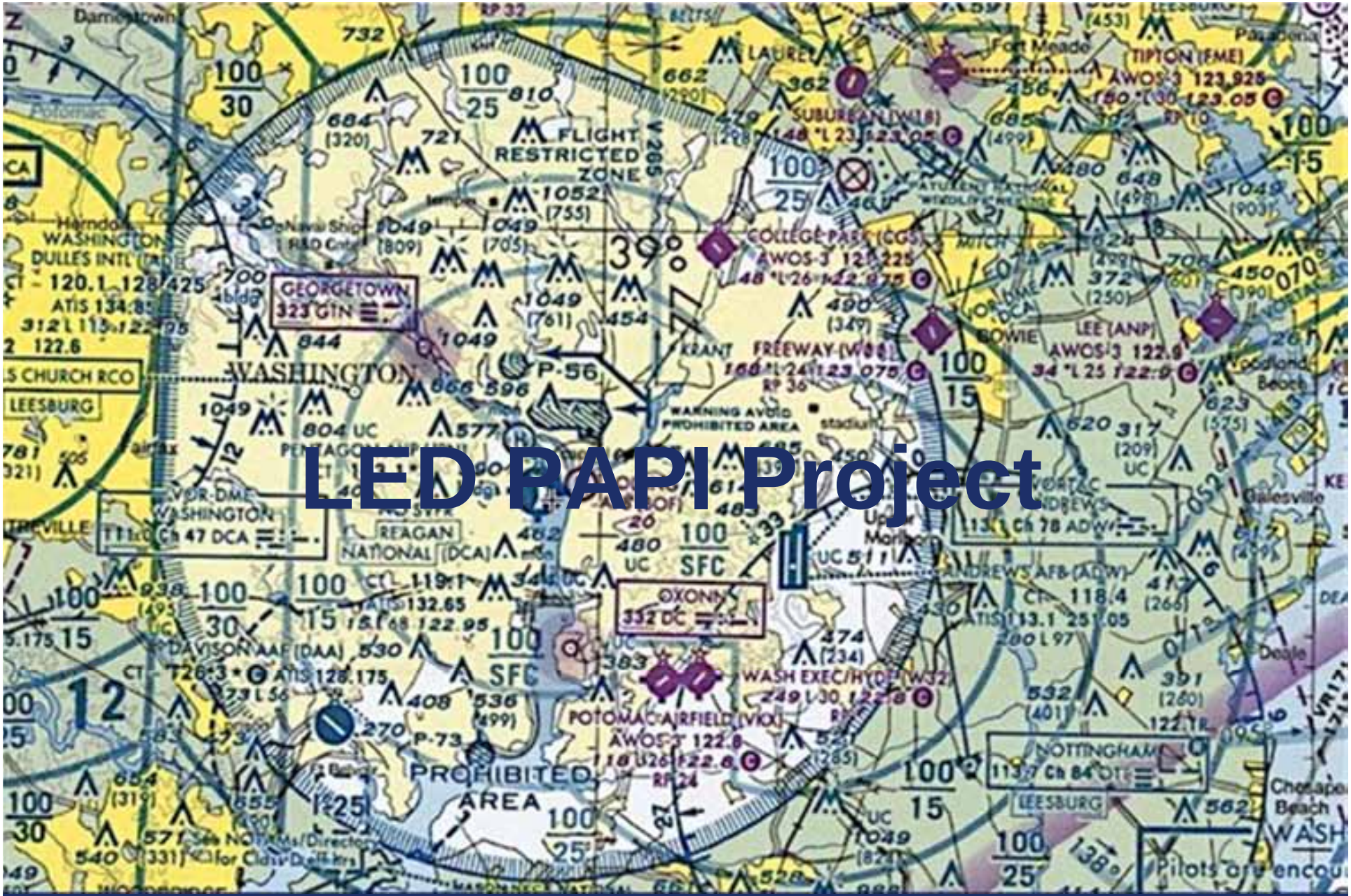


Roadmap to the Future

- RVRs are required for the current and future NAS operations to
  - Replace aging transmissometers and non-PC-based systems
  - Support future precision approach requirements

Lighting Systems Future Initiatives

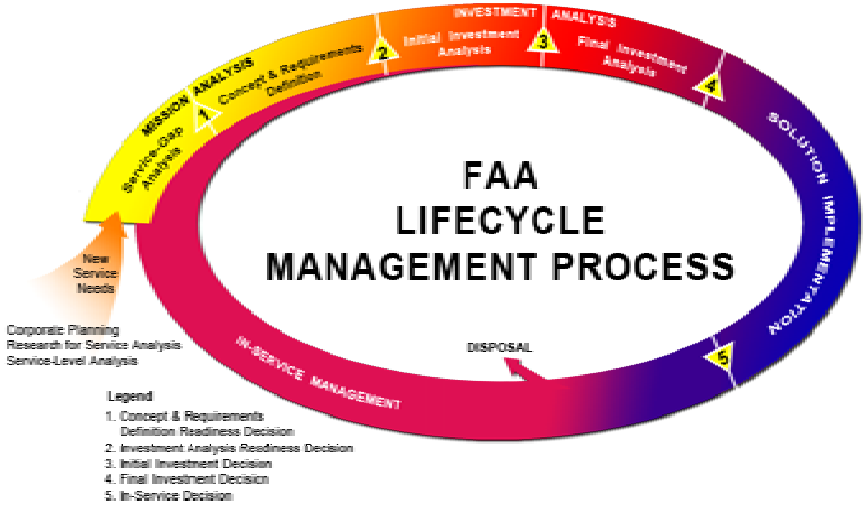
- ALSF-2/MALSR : Conduct Analysis on the feasibility of reducing the footprints of these lighting systems
- Redesign MALSR system based on LED technology
- Redesign ALSF-2 system based on LED technology


LED PAPI Project

PAPI LED Project

- Objective: The primary objective is to fully deploy LED PAPI by using the System Development, Deployment and Implementation phases of FAA's Acquisition Management Systems (FAMS) process.

  - Project Activities
    - Preliminary Design Review
    - Critical Design Review
    - Design Qualification Test
    - Operational Test
    - Configuration Audits
    - Product Baseline
    - In-Service Management

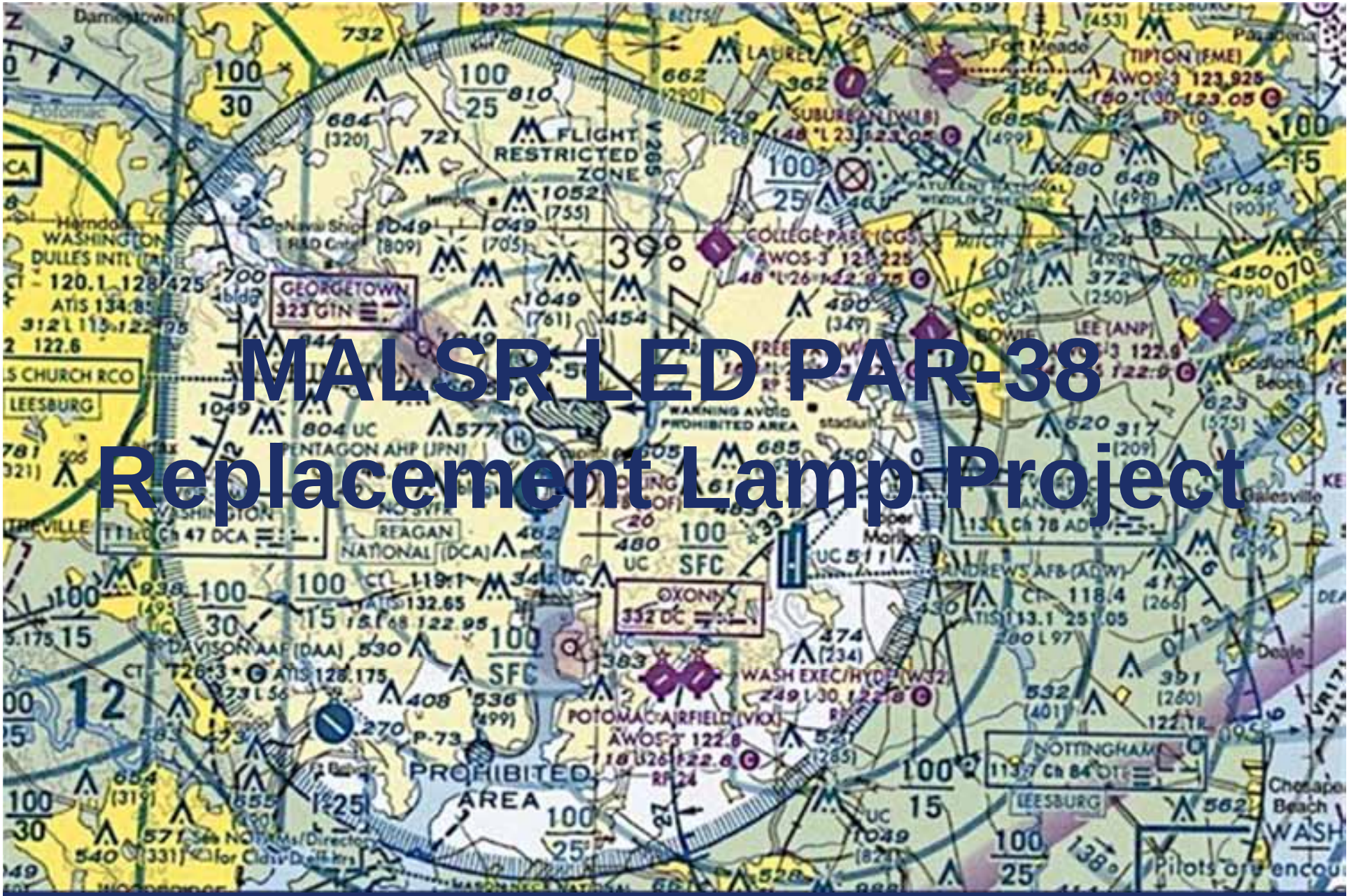


PAPI LED Project

Current Status

- Conducted the Functional Configuration Audit /Physical Configuration Audit and the Provisioning Conference, April 2014
- Projected In-Service Decision, April 2015
- LED PAPI systems available by 4th Quarter 2015
- Tentative plans to install at three (3) locations

PAPI Flight Comparison


MALSR LED PAR-38
Replacement Lamp Project

MALSR LED PAR-38 Replacement Lamp Project

- **Objective:** Determine the I/R requirements for a PAR-38 LED replacement lamp. This will includes a feasibility study, developing requirements and evaluating the concept by prototyping, testing and conducting operational capabilities demonstrations.
  - **Phase I:**
    - **Conduct Feasibility Study to determine if integrating IR into a LED Par 38 and Par 56 fixtures is achievable.**
  - **Phase II:**
    - **Procure prototype MALSR LED replacement lamps and conduct Confidence Test**
    - **Procure MALSR LED replacement lamps and conduct an Operational Capability Demonstration (OCD) with EFVS-equipped aircraft**
  - **Phase III:**
    - LED Lamp First Article development
    - Design Qualification Tests
    - FAA Operational Evaluation

Test Activities

Confidence Test

- Validate “numbers” to ensure we are in the same ballpark and that technologies are compatible under simulated low-visibility conditions
- Photometric and EVS testing

Pre-Flight Test

- Consists of “Laboratory” and/or “Field” testing
- Accomplish the “easy” stuff before tackling the weather!
- Ensure “look-and-feel” is validated before committing to flight

Flight Test (OCD) & Duration Testing (Volpe)

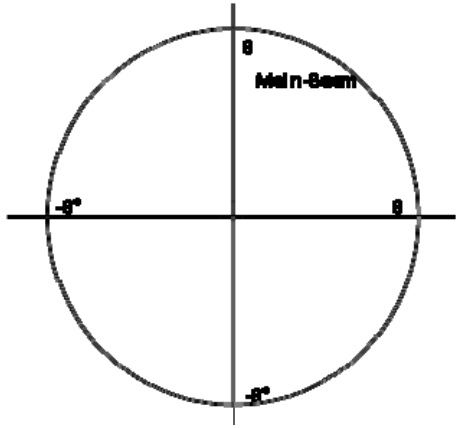
- Formal Flight Testing –chasing “relevant” wx will prove challenging
- Continue “static” weather related testing to supplement flight testing

Confidence Test

FAA Photometric Testing

What: PRD 4.4.3.2: Measure average intensity, maximum intensity, chromaticity

Pattern	Steady Burning Average Intensity (Candela)		
	Low (4%)	Medium (20%)	High (100%)
Main Beam (±8°)	400 ± 60	2,000 ± 300	10,000 ± 1500

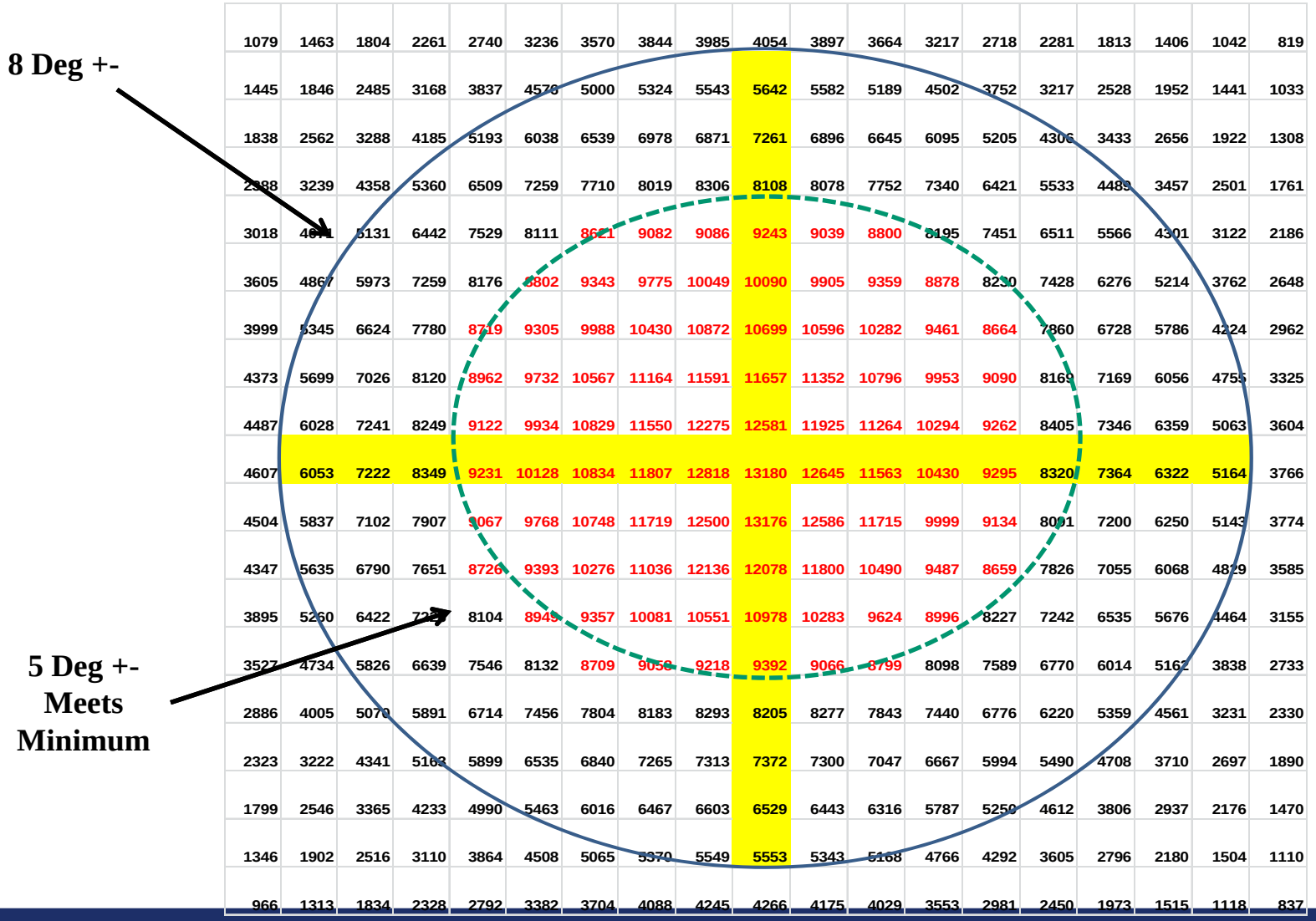


Where: FAA Technical Center (Atlantic City, NJ)

When: August 14th, 15th, & 16th, 2012

Results: Validated Requirements

FAA Photometric Test



Average = 9372 cd

Maximum = 13180 cd

Confidence Test

EVS Ground Testing

What: Test the cameras' ability to image the lamps in quantities of digital units, pixels and analysis of the images for the documented EVS camera test settings in a laboratory test environment at short range.

Where: Kollsman Facility (Merrimack, NH)

When: August 7th ,8th, and 9th 2012

Results: Determined EVS cameras can image LED's

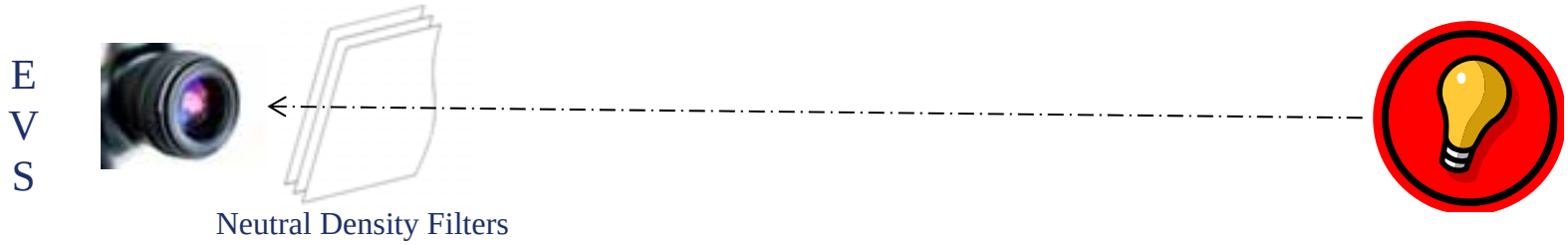
EVS Ground Test

EVS Camera Test Equipment

- PAR-38 power supply
- PAR-38 60W MALSR Lamp
- PAR-38 150W MALSR Lamp
- LED/IR MALSR LRU 1, power supply and controller
- LED/IR MALSR LRU 2, power supply and controller
- MALSR Lamp Holder
- Goniometer
- EVS camera I, power supply and computer
- Data collection equipment for EVS camera I
- EVS camera II, power supply and computer
- Data collection equipment for EVS camera II
- 5 Neutral Density filters and mounts (Optical Density 0.3, 0.7, 1, 2, and 3) OD = 7

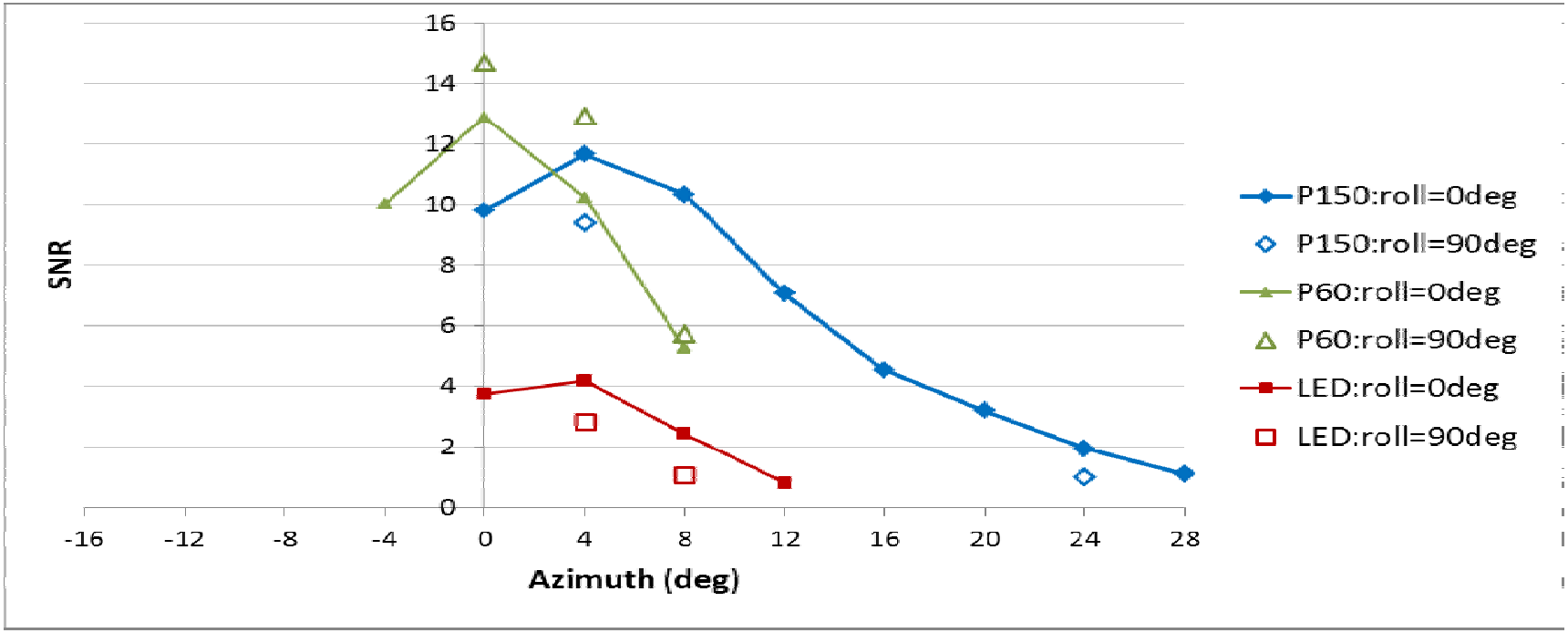
EVS Ground Test

- Test Set-up
  - Controlled laboratory environment that is free from stray external illumination
  - Laboratory camera-to-lamp test distance shall be a minimum of 25 meters.
  - Dark background Field of Regard for the EVS cameras shall be greater than 10 times the image size (pixel [*x*, *y*]) of the lamp test units



EVS Camera Test Results

	Maximal on-axis Power (SNR)	FWHM	Total Power normalized over a hemisphere	Total Power normalized to PAR38 150W
PAR38 150W	11.7	7.65	8.98	1
PAR38 60W	14.7	6.90	2.57	0.29
LED	4.2	4.00	0.94	0.11



Confidence Test Conclusions

- Photometric requirements were met
- EVS Cameras displayed LED Prototype images on monitor
- LED Prototype IR were still visible through Neutral Density filters as high as 3.5 OD - equivalent to 0.0316% transmission of signal to camera
- Test Results (Photometric, Radiometer and EVS Camera) were encouraging

Pre-Flight Testing

- Consists of “Laboratory” and/or “Field” testing
- Accomplish the “easy” stuff before tackling the weather!
- Ensure “look-and-feel” is validated before committing to flight

Pre-Flight (Laboratory Testing)

Completed Test

- Temperature
- Humidity
- Altitude
- Salt Fog
- Wind and Rain
- Photometric
- Chromaticity
- Infrared
- Power Interruption
- Voltage Variation
- Voltage Harmonic
- Current Harmonic
- Power Factor
- Power Line Surge
- Power Consumption
- LED Circuitry Temperature
- Weight
- Pulse Repetition Rate

Ongoing Test

- Sand and Dust
- Vibration
- Ice Accumulation
- Grounding and Bonding
- EMI

Pre-Flight (Laboratory Testing)

- Infrared Measurements
  - Spectral irradiance measurements of the LED light source, at each intensity step, shall be made over the wavelength of 1,000 nm to 5,000nm in 50 nm increments

Sample Number	CRT1308211113-001-1					Input Voltage	120	Vac
Warm-Up	15 minutes					Intensity Level	High	
Angular Radiant Intensity (W/Steradian) 1,300nm - 2,400nm								
Vertical	Horizontal Degrees							
Degrees	-8.0	-6.0	-4.0	-2.0	0.0	2.0	4.0	6.0	8.0
8.0	3.5	4.7	6.7	8.2	8.9	8.6	7.4	5.7	4.4
6.0	4.4	6.2	11.1	13.9	14.9	14.1	11.9	8.7	5.7
4.0	6.1	10.0	20.0	25.1	26.3	23.2	18.4	13.5	8.4
2.0	7.8	14.3	30.5	40.0	42.3	36.2	25.6	17.3	11.0
0.0	8.6	17.3	37.1	46.4	50.7	46.5	33.8	20.4	12.8
-2.0	8.6	17.6	38.1	47.3	51.3	47.4	32.3	19.8	12.2
-4.0	7.1	14.2	32.7	42.1	45.2	40.6	26.1	16.4	10.0
-6.0	6.0	10.2	23.4	30.6	32.0	26.1	18.8	12.2	7.7
-8.0	4.8	7.4	14.0	18.0	18.4	16.0	12.0	8.2	5.6

Input	Int. Level	Position	W/Str.	Ratio
120Vac	High	H-V	33.8	NA
75Vac	Med	H-V	33.8	1.00
50Vac	Low	H-V	33.8	1.00

Pre-Flight Test (Laboratory Testing)

- Infrared Measurement Comparison

	Confidence 8/12	Lab 9/13
Total Power Normalized to the PAR-38 150W		
150w	1	1
60w	.29	.82
LED	1st Generation	2nd Generation
	.11	.39

OCD (Flight Test)

- Formal Flight Testing
  - Chasing “relevant” weather will prove challenging

- Requirement Verification and data gather effort
  - Current applications, standards, and specifications to demonstrate overall NAS operational capability

OCD (Flight Test)

Incandescent MALSR 200FT AGL

OCD (Flight Test)

LED MALSR 200FT AGL

LED PAR-38 Replacement Project Summary

- LED PAR-38 met majority of requirements in our LED Performance Requirements Document (LED-PRD-001)
  - Photometrics
  - Chromaticity

- Seven (7) flights were conducted during clear weather

- Without weather could not validate if LED's with IR is sufficient for EFVS operations during Category I weather
  - Very encouraged with results even without weather

- Planned to move forward but…

Aviation Weekly Article

Approach Lights Problems Lead To Broader Examination Of LED Rollout

- "The lights are overpowering, blotting out visibility."
- "The fundamental problem is that these lights have been fielded with no testing done,"
- "… FAA has not conducted testing to determine the potential effect of the lights on pilots at night and in different weather conditions, including rain, fog, smoke, haze and "break out effects" when a pilot descends below low cloud bases on an instrument approach.
- "develop a flight-test plan which will include appropriate FAA technical service organizations as well as industry operators, aircraft and avionics manufacturers"

Pictures Are Worth 1000 Words!

With The Right Camera!

Sometimes Bright Lights are good ...

… and sometimes they're not!

Severe IMC (300 RVR)

Severe VMC

LED Symposium (October 7th and 8th)

- Objective:
  - Focus is on Approach Lighting
  - Identify needed Areas of Research and Testing
  - Achieve Collaboration from Stakeholders
  - Establish Plan of Action and Timelines
  - Fix It!

- Presenters:
  - Industry: ALPA, RPI, ADB, Gulfstream
  - FAA: Navigation Programs, Airports, Tech Center, Flight Standards, CAMI, Volpe

- Outcome:
  - Established Three (3) Groups
    - Science, Infrastructure and Operational

Effects on LED Projects

- Test alternate incandescent lamps that meets the Energy Act
- More Flight Testing
  - Visual (Fog, Rain, Snow, etc)
  - I/R (Fog, Rain, Snow, etc.)
- More Science Studies
- Revalidate of Requirements
  - Intensity Steps
  - Photometrics
  - Brightness
- Significantly impacts schedule and changes the scope
  - LED PAR-38 Replacement
  - LED PAPI

Next Steps

- Work with Stakeholders and FAA to identify resources needed to continue evaluation of LED Technology
  - Acquisition of new lamp technology
  - Developmental Testing
  - Operational Testing (static and dynamic)
  - Safety Management System evaluations
  - Configuration Management actions
  - Acquisition Planning
  - Implementation

Other Lighting Projects

Replacement Lamp Monitoring System (RLMS)

- Objective:
  - To replace the constant current regulators and implement lamp monitoring on the Airflow and Godfrey ALSF-2 systems.

- Status:
  - Procuring and installing RLMS kits
    - Denver, CO
  - Resolving issue of part obsolescence

LEAD-In Lights

- The Lead-In Lighting System (LDIN) is a visual navigational aid used for flying visual and instrument approach procedures where special problems exist with hazardous terrain, obstructions, or noise abatement procedures.
  - There are currently 14 LDINs installed
- Objective:
  - To replace the LDIN lights at JFK (TLK Bank)
- Status:
  - Successful returned to service the LDIN (TLK) at JFK International Airport, April 2014
  - Coordinate plans to replace other banks
    - JFK QPP 13R Jamaica, NY
    - JFK TLKB 13L Canarsie, NY
    - JFK TLKC 13L Canarsie, NY
    - JFK TLKD 13L Canarsie, NY

Low-Voltage Individual Control Cabinet (LVICC)

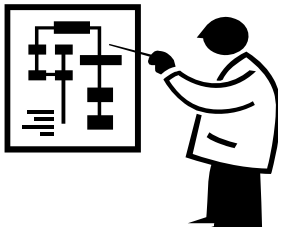
- Objective:
  - To develop and approve an ICC that reduces the voltage from 2000V to 400V and interfaces with semiflush flashers. LVICC is compatible with MALSR and ALSF-2 systems

- Status:
  - Conducting Operational Test
  - Updating MALSR and ALSF-2 product baseline
  - Updating training material for technicians
  - Installed at various locations
    - Flagstaff, AZ
    - San Jose, CA

Semi-Flush Flasher Light Unit (SFFLU)

- Objective:
  - To develop and approve a semiflush flashers light unit through the FAA's Developmental Hardware Process.

- Status:
  - Completed Development Test
  - Initiating Operational Test Activities
  - Installed SFFLU at various locations
    - Flagstaff, AZ
    - San Jose, CA



Specification Updates

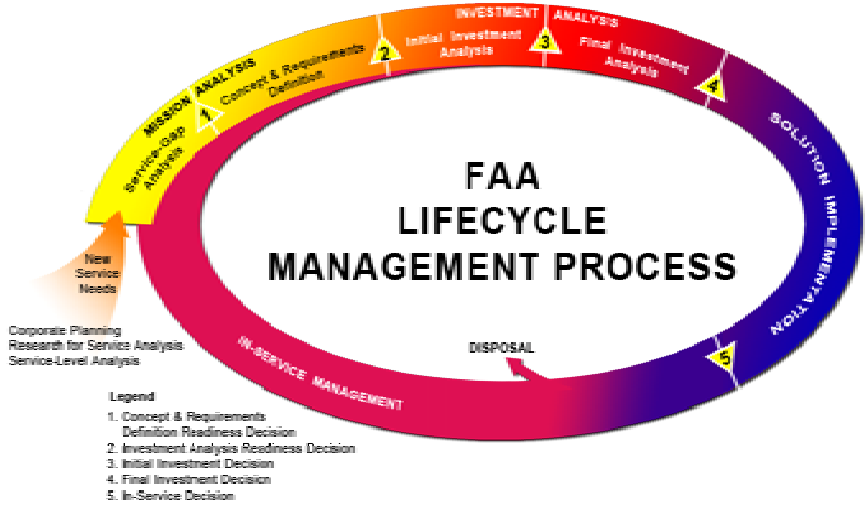
- **RVR Specification**
  - Anticipated Approval (March 2015)
- **Radio Remote Control System**
  - Anticipated Approval (November 2015)
- **REIL Specification**
  - Anticipated Approval (TBD)
- **MALSR Specification**
  - Anticipated Approval (TBD)
- **ALSF-2 Specification**
  - Anticipated Approval (TBD)

Procurement Opportunities

- You should continue to monitor the FAA Contracting Opportunities Website for procurement opportunities

FAA Contracting Opportunities website:

https://faaco.faa.gov/



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Questions