

# International Flight Inspection Symposium

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## Initial Federal Aviation Administration (FAA) Flight Inspection Criteria for Precision Instrument Approach Procedures Supported by the Local Area Augmentation System (LAAS)

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# Overview

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- Background
  - Global Positioning System (GPS)
  - Local Area Augmentation System (LAAS)
  - Conceptual discussions (i.e. equation free!)
- FAA LAAS flight inspection criteria
  - Why flight inspection is needed
  - Rationale used to develop FAA criteria
- Overview of FAA draft Order 8200.LAAS
- Closing comments

# GPS Overview

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- Provides position, velocity and time (PVT) determination
- Components
  - Satellite constellation
  - Operational control segment
  - User segment (receiver)
- Standard Positioning Service (SPS)
  - Augmentation needed to meet aviation accuracy, integrity, availability and/or continuity requirements
  - Augmentations:
    - Airborne based augmentation system (ABAS)
    - Space based augmentation system (SBAS)
    - Ground based augmentation system (GBAS)

# LAAS Overview

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- LAAS is the USA “realization” of GBAS
- Provides more accurate position, velocity and time with integrity
- Components
  - Satellite subsystem
  - Ground subsystem > LAAS Ground Facility (LGF)
  - User subsystem (LAAS receiver)
- Supports
  - Typical service: 20 nm, 10,000 feet
  - Approach/precision approach
  - Departures
  - Terminal Area Path (TAP)
  - Airport surface operations
  - PVT source for Automatic Dependent Surveillance Broadcast (ADS-B)
- Uses earth-centered, earth-fixed (ECEF) reference system (WGS-84 datum)
  - Not source reference like conventional radio navigation system
  - Importance of relative/absolute survey accuracy

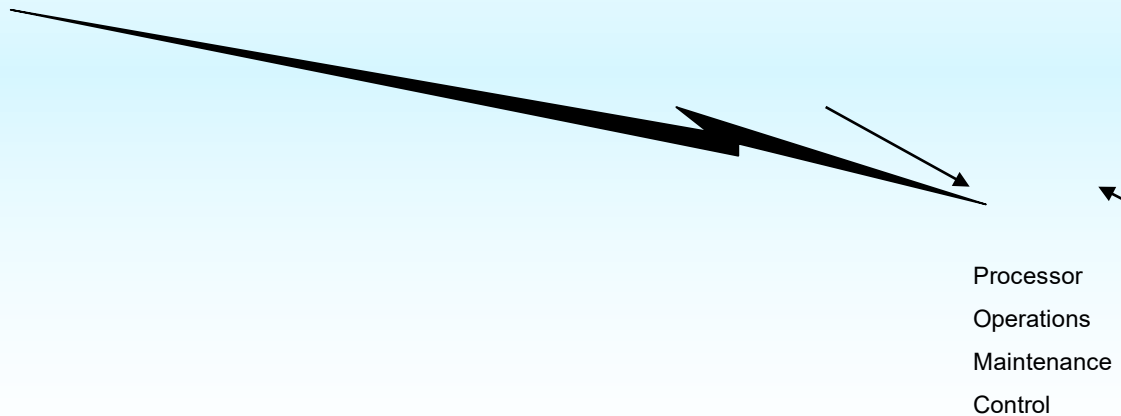
# LGF Overview

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- It is the subsystem that is “flight inspected”
- Paper discusses in detail
- Components
  - Reference receivers, associated antennas
  - VHF Data Broadcast (VDB) equipment, associated antennas
  - Processor (hardware, software, database....)
  - Operations and Maintenance
- Provides
  - Broadcast of monitored differential range corrections
  - Satellite health/status information
  - Procedure path point data, including FAS data block

# GPS/LAAS Components

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# Reference Receiver Antenna

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Reference Receiver Antennas  
(Demonstration system at  
Dallas-Fort Worth  
International Airport)

# LAAS Implementation in USA

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- Implementation Process
  - Develop operational requirements
  - Formulate candidate system architectures
  - Specify minimum performance in terms of system architecture specific parameters
  - Generate performance verification procedures
- Includes the development and validation of LAAS flight inspection criteria



# LAAS Inspection Criteria Development

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- High-level Process
  - Identify objectives and parameters to be assessed
  - Generate assessment procedures and tolerances
    - Conditions required to put facility/procedure in service
  - Develop inspection criteria and procedure that facilitate effective, efficient sampling of service volume
  - Verify inspection criteria and procedures
    - Implementation of initial criteria/procedures
    - Assessment based on operational experience
    - Revision to improve effectiveness, efficiency

# LAAS Inspection Criteria Development

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- Rationale
  - Consider test/qualification activities accomplished prior to flight inspection
    - Airborne equipment/installation
    - LGF equipment/installation
    - Flight inspection not intended/required to accomplish above activities
  - Assess site-specific elements of LAAS procedures and confirm availability of service
    - Confirm procedure design
    - Verify segment alignments
    - Assess obstacle clearance
    - Confirm GPS/VDB signal reception in service volume
  - System accuracy performance
    - Traditionally assessed for ground-based navigation aids
    - LAAS accuracy time varying on sub-hourly basis
    - Must be monitored by LGF in range domain
    - In-tolerance position domain accuracy performance necessary condition
    - Position domain measurement made during flight inspection provide meaningful functional test

# LAAS Inspection Criteria Development

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- Require flight inspection
  - Prior to commissioning on each runway served for each procedure
  - When interference is reported, suspected and elimination cannot be verified on ground
  - Existing procedures are revised or new procedures are introduced
  - Specific changes to LGF hardware/software
  - Physical site changes that could effect VDB coverage or GPS signal reception

# Overview FAA Draft Order 8200.LAAS

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- Contains inspection procedures, requirements, and evaluation methods for LAAS
- Applies to LAAS approach procedures with decision altitudes  $\geq 200$  ft AGL
- Placeholders for TAP and airport surface
- Contents
  - Cover letter
  - Appendix 1, background material on LAAS
  - Appendix 2, flight inspection procedures
  - Appendix 3, flight inspection records and reports
  - Appendix 4 acronyms and definitions
- Paper focuses on overview of appendix 2
- Presentation highlights this overview (~overview<sup>2</sup>)

# Appendix 2 - Draft Order 8200.LAAS

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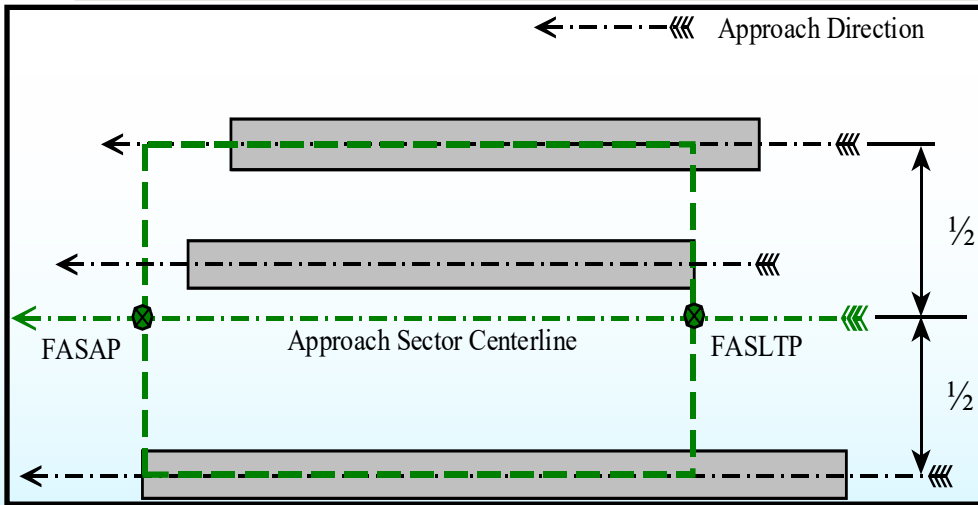
- Addresses
  - Pre-flight requirements
    - Required system calibrations
    - Determine LAAS maximum use distance ( $D_{max}$ )
    - FAS data block coding, download, confirmation
    - **Pre-flight requirements for parallel runways sites**
  - Flight inspection procedures
    - Commissioning, periodic, special inspections
      - Periodic: change in environment, modification of procedure
      - Special: select maintenance/repair, user complaints
    - VDB coverage assessment
    - Instrument approach procedure assessments
  - Flight inspection analysis and tolerances

# Parallel Runway Sites

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- Define approach sectors
  - Bound airspace common to all approach procedures have same landing direction
    - Fictitious Approach Sector Alignment Point (FASAP)
    - Fictitious Approach Sector Landing Threshold Point (FASLTP)
    - Right Boundary Alignment Points #1, #2 (RBAP1/2)
    - Left Boundary Alignment Points #1, #2 (LBAP1/2)
  - Two approach sectors per parallel runway group
  - Permits sufficient assessment of each procedure
  - Improves efficiency by eliminating redundant VDB coverage assessments

# Parallel Runway Sites

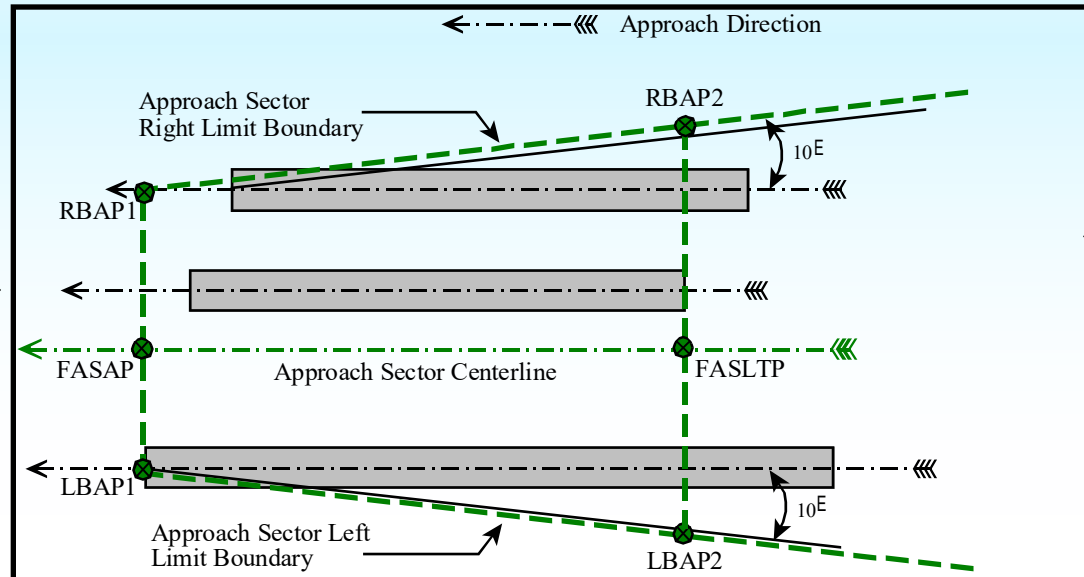


**DETERMINE**

- Fictitious Approach Sector Alignment Point (FASAP)
- Fictitious Approach Sector Landing Threshold Point (FASLTP)

**DETERMINE**

- Right Boundary Alignment Points #1, #2 (RBAP1/2)
- Left Boundary Alignment Points #1, #2 (LBAP1/2)



# Condensed/Combined Tables 1 & 2

Requirement	Evaluation Area	Basic Method (Single Runway)	Modified Method (Parallel Runways)	Done for	Measured Value
Normal Approach	From 20 NM to LTP	Fly on path, on course	No change	Each approach procedure	1) LAAS Receiver maintains "GBAS" Integrity 2) No CDI Flags
Lower-Limit of Approach	From 20 NM to LTP	From 21 NM and 5000 above LGF, fly on course, intercept and fly glide path within 1 dot of full scale below path	No change	Each approach procedure	Same as above
.....					
Left-Limit of Approach	From 20 NM to LTP	From 21 NM, fly on path and offset course to within 1 dot of full scale of "fly right"	From 21 NM, on path and fly along left limit of approach sector boundary	For left limit of each approach sector	1) LAAS Receiver maintains "GBAS" Integrity 2) No CDI Flags
Right-Limit of Approach	From 20 NM to LTP	From 21 NM, fly on path and offset course to within 1 dot of full scale of "fly left"	From 21 NM, on path and fly along right limit of approach sector boundary	For right limit of each approach sector	1) LAAS Receiver maintains "GBAS" Integrity 2) No CDI Flags
.....					
Missed Approach	From Runway Stop End to 4 NM	Fly runway course, climb at 200 feet per NM	No change	Each approach procedure	1) LAAS Receiver maintains "GBAS" Integrity 2) No CDI Flags
Roll Out	From Runway End to Runway End	Taxi along runway	No change	Once for each runway	1) LAAS Receiver maintains "GBAS" Integrity 2) No Lateral CDI Flags



# Parameters Recorded, Tolerances

Table 3. GPS Satellite Parameters Recorded

Parameter	Expected Values
Horizontal Protection Level (HPL <sub>GBAS</sub> )	≤ 10m
Vertical Protection Level (VPL <sub>GBAS</sub> )	≤ 10m
Horizontal Dilution of Precision (HDOP)	≤ 4.0
Vertical Dilution of Precision (VDOP)	≤ 4.0
Horizontal Integrity Limit (HIL)	≤ 0.3nm
Figure of Merit (FOM)	≤ 22meters
Satellites Tracked	5 Minimum
Signal-to-Noise Ratio (SNR)	30 dB/ Hz minimum

Table 4. Tolerances for LAAS Flight Inspection

Parameter	Tolerances
Terminal Area Path	(Reserved)
Initial/Intermediate Approach Segment	FAA Order 8200.1
Final Approach Segment FAS data: Bearing to LTP Glidepath Angle FAS Data CRC Threshold Crossing Height Course Alignment w/runway C/L	± 0.1° true course ± 0.05° No Corruption ±2 m Centerline
Missed Approach Segment	FAA Order 8200.1
Coverage VDB signal	Indicates GBAS mode
Horizontal Protection Level Vertical Protection Level	40m 10m
Co-channel / adjacent channels (VOR or ILS) Annex 10, V1, Atch D Para 7.2	No misleading information
RFI	No misleading information
Maximum Usable Distance (D <sub>max</sub> )	As defined by LGF Site.

# Closing Comments

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- Provided overview of FAA DRAFT Order 8200.LAAS
  - Not intended to provide verbatim citation
  - Inform flight inspection community of its status
  - Share insight used to develop order
  - Promote continued discussion of subject
- Future activities
  - TAP and Airport Surface
    - Under development
    - Initial criteria/procedures expected fall 2008
  - Order Revisions
    - As experience is gained
    - As Category II/III equipment becomes available