GBAS Approval Process

Honeywell, Precision Landing Systems
Agenda

• FAA System Design Approval
  – Integrity Panel
• Ionosphere Mitigation
• GBAS Approval by Country
• GAST-D (CAT II/III)
GBAS Certification Phases

- **System Design Approval (SDA) – Manufacturer**
  - Ground station system design meets requirements
  - Developed to appropriate design assurance levels
  - Accuracy, integrity, availability requirements satisfied

- **Facility Approval – Owner/ANSP/Airport**
  - Ground station installed properly, safely
  - Approach plates/procedures developed
  - Signal-in-space, coverage volume verified, approaches verified
  - Maintenance technicians trained, certified

- **Service Approval – Operator/Airline**
  - Aircraft equipped
  - Pilot crews trained
  - Control tower personnel trained

- FAA approved 2009
- BAF approved 2011

Bremen, Germany
Newark, New Jersey
Houston, Texas
Malaga, Spain
Sydney, Australia
Frankfurt, Germany
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FAA System Design Approval

Honeywell
GBAS CAT I Approval Steps

- To be approved the system must meet ICAO, FAA and/or other recognized standard
- The standard for SmartPath is the FAA LAAS Specification 3017 which also traces to the ICAO requirements

**SYSTEM DESIGN APPROVAL**
- System Safety
- System Engineering
- Software Design Assurance
- Hardware Design Assurance
- System Verification
- Commercial Instruction Book
- Training Material
- System SRMD
- Operational Evaluation

**FACILITY APPROVAL**
- Operations
- Maintenance
- Installation
- Flight Procedures
- Flight Inspection
- Spectrum Management
- Training
- Safety Management

**SERVICE APPROVAL**
- Aircraft Approval
- ATC Training
- Pilot Training
- Instrument Flight Criteria
Customer Requirements

Requirements
- ICAO SARPS
- FAA Specification 3017

Secondary Requirements
- DO-246C, GBAS Signal in Space
- DO-245A, MASPS for GBAS
- Mil-Std-461E, Electromagnetic Interference
- Mil-Std-810F, Environmental Tests
- FAA-G-2100G, Electronic Equipment
- ED-114, MOPS for GBAS

Process Requirements
- ARP-4754, Certification Considerations
- ARP-4761, Safety Process
- DO-278/DO-178, Software
- DO-254, Hardware
GBAS CAT I Approval Plan

• GBAS Approval Plan
  – Provides the FAA with Honeywell’s plan to achieve design approval for the GBAS system
  – Approval basis includes
    • Requirements
    • Compliance method
    • Data
    • Schedule
    • Responsibilities
GBAS CAT I Approval Plan

- System Engineering Management Plan
- Configuration Management Plan (CMP)
- GBAS System Description Document
- Functional Hazard Assessment (FHA)
- Algorithm Description & Analysis Document
- GBAS System Requirements Specification (SRS)
- Interface Control Documents
- Preliminary System Safety Assessment (PSSA)
- GBAS System Verification Plan
- GBAS System Verification
- GBAS System Safety Assessment

GBAS Approval Summary

DCP PSAA/SAS (Honeywell)

Deos PSAC/SAS (Honeywell)

Remote Power Distribution Panel PSAA/SAS (Honeywell)

GPS Receiver PSAC/SAS (CMC Electronics)

VDB TX/RX PSAC/SAS (Telrad)

DCP PHAC/HAS (Honeywell)

GPS Receiver PHAC/HAS (CMC Electronics)
FAA Approval Process

- System Design Approval Plan CAT I Local Area Augmentation System (LAAS)
  - Provides top-level SDA plans and activities for use by FAA personnel

- System Design Approval Process And Procedures for The CAT I Local Area Augmentation System
  - Defines the evaluation criteria for all reviews necessary to accomplish System Design Approval

- These documents describe the objectives, activities and documentation to:
  - Verify compliance to the requirements
  - Define design data that substantiates compliance
  - Document accepted configuration
Safety Definitions

• Integrity – The probability of transmitting out-of-tolerance navigation data for 3-seconds or longer in any 150-second interval

• Continuity – The probability of an unscheduled interruption of the VHF transmission for 3-seconds or longer in any 15 second interval

• Availability – The proportion of time during which service is provided, computed over a long period (typically a year)
Safety Requirements

• Severe-Major Hazard Classification
  – Approach Integrity due to LGF failure, anomalous environmental or atmospheric effects – $1.5 \times 10^{-7}$ in 150-seconds
  – Approach Integrity under fault free or no more than Reference Receiver fault – $5 \times 10^{-8}$ in 150-seconds

• Minor Hazard Classification
  – Unscheduled interruption of VDB transmission (Loss of Continuity) – $1.0 \times 10^{-6}$ in 15-seconds
  – Unscheduled loss of sufficient Reference Receivers or Ranging Sources (Loss of Continuity) – $2.3 \times 10^{-6}$ in 15-seconds

• Availability – 0.99 (goal)
LAAS Integrity Panel

• **Purpose**
  – Ensure GBAS integrity monitors address defined GPS threats

• **Team**
  – Honeywell, FAA (10), Subject Matter Experts (11 Key Technical Advisors)

• **Process**
  – 10 years development
  – 20 Technical Interchange Meetings
  – Review development of integrity monitors
  – Approve integrity monitors
# Integrity Algorithms

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<td>Cross Correlation Monitor</td>
<td>Iono Gradient Monitor</td>
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**GAST-C provides foundation for GAST-D**

**CAT III monitors developed**
FAA System Design Approval

- System Design Approval
  - System Safety Assessment
    - Preliminary System Safety Assessment
      - Algorithm Description Document
    - SRMD (System Design Aspects)
    - FMEA/FMES
  - Functional Hazard Assessment
  - System Level Verification
  - Systems Engineering Review
  - SW Design Assurance Reviews
  - Complex HW Design Assurance Reviews
  - HMI Analysis/Report
  - SW Design Assurance Reviews
  - Training Material Review
    - Commercial Instruction Book Review
Ionosphere Mitigation
Ionosphere Threat Model

- Independent ionosphere analysis performed by following countries
  - United States
  - Germany
  - Spain
  - Australia
  - Switzerland
  - Brazil
- Approved Honeywell GBAS addresses mid-latitude iono
- Honeywell is developing an update to address low-latitude iono
Rare Anomalous Iono

\[ D = w g \]

\[ \text{Front Speed} \ (v) \]

\[ \text{Nominal Iono Width} \ (w) \]

\[ \text{Iono Front Slope} \ (g) \]

\[ \text{Max Iono Delay} \]

\[ \text{Gradient} = \text{Slope} \ (g) \]

Results in integrity/position error
Iono Error at Decision Height

200 ft DH

< 6 km
Iono Scintillation

Impacts availability of GBAS
Equatorial Scintillation

- Amplitude and phase of GPS signals change rapidly
- Degradation of measurements
  - Enhanced error
- Loss-of-lock of satellite signals
  - Degradation of geometry, less accuracy, availability issue
- Occurs local sunset to local midnight
GBAS Approval by Country

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Germany

- Country requirements for type certification
- Top level requirements: ICAO
- Honeywell responsible to obtain type certification with BAF
Germany - Requirements

- NfL II-51/08, Notification concerning the requirements for type-certification of GBAS ground facilities as aeronautical radionavigation stations
  - System safety and security
    - ICAO Annex 10, Volume 1
    - ARP4761, Safety Assessment Process
  - Software requirements
    - Developed according to EUROCAE ED-109
  - Technical functional requirements
    - ICAO Annex 10, Volume 1
    - Tests per EUROCAE ED-114
    - Ground and Flight inspections per ICAO Doc 8071 chapter 4
    - All weather operations, NfL I-1/99
    - Remote monitoring
  - Environmental requirements
    - ED-114
    - NfL I-328/01, Guidelines Concerning Obstacle Clearance for Instrument Runways
Germany - Requirements

• NfL II-51/08, Notification concerning the requirements for type-certification of GBAS ground facilities as aeronautical radionavigation stations
  – Facility Documentation
    • Installation manual
    • Technical system description
    • Operators manual
    • Maintenance manual
  – Legal telecommunication requirements
    • Declaration of conformity to radio equipment and telecommunications standards
  – Applicable to Cat I operations
  – Independent audit of Honeywell’s FAA SDA data package
Spain

- Top level requirements: FAA specification
- Aena prepared approval package for certification authority

Malaga
Australia

• Top level requirements: FAA specification
• Airservices Australia prepared approval package for certification authority
• Certification authority CASA participated in FAA audits
Switzerland

• Switzerland approval agency stated that they don’t approve NAVAIDS. It is the responsibility of the ANSP to purchase an approved system.

• Switzerland approval agency is interested to see safety case for how the new NAVAID is integrated into the airport’s operation

• Honeywell provided a documentation package that defines the SmartPath system
Brazil

- Top level requirements: ICAO
- Approval agency ICEA is working with the FAA on approval of the Honeywell SmartPath for low-latitude
  - ICEA participates in FAA audit meetings
- ICEA needs to address iono threat model for Brazil
  - Independent iono analysis
  - Honeywell iono analysis
- Honeywell will submit design approval documents to ICEA
India

- Top level requirements: ICAO
- Honeywell will submit approval documents to Airports Authority of India and approval agency DGCA

Chennai
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GAST-D (CAT II/III)
GAST-D (CAT II/III)

- Honeywell has initiated an FAA approval plan for a GAST-D system
- Core architecture unchanged from GAST-C SLS-4000 system
- Two new monitors for GAST-D
- Requirements prototyped and validated by the FAA