



Honeywell, Precision Landing Systems

GBAS Approval Process

Honeywell

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

FAA approved 2009
BAF approved 2011
- **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

Bremen, Germany
Newark, New Jersey
Houston, Texas
Malaga, Spain
Sydney, Australia
Frankfurt, Germany



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FAA System Design Approval

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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

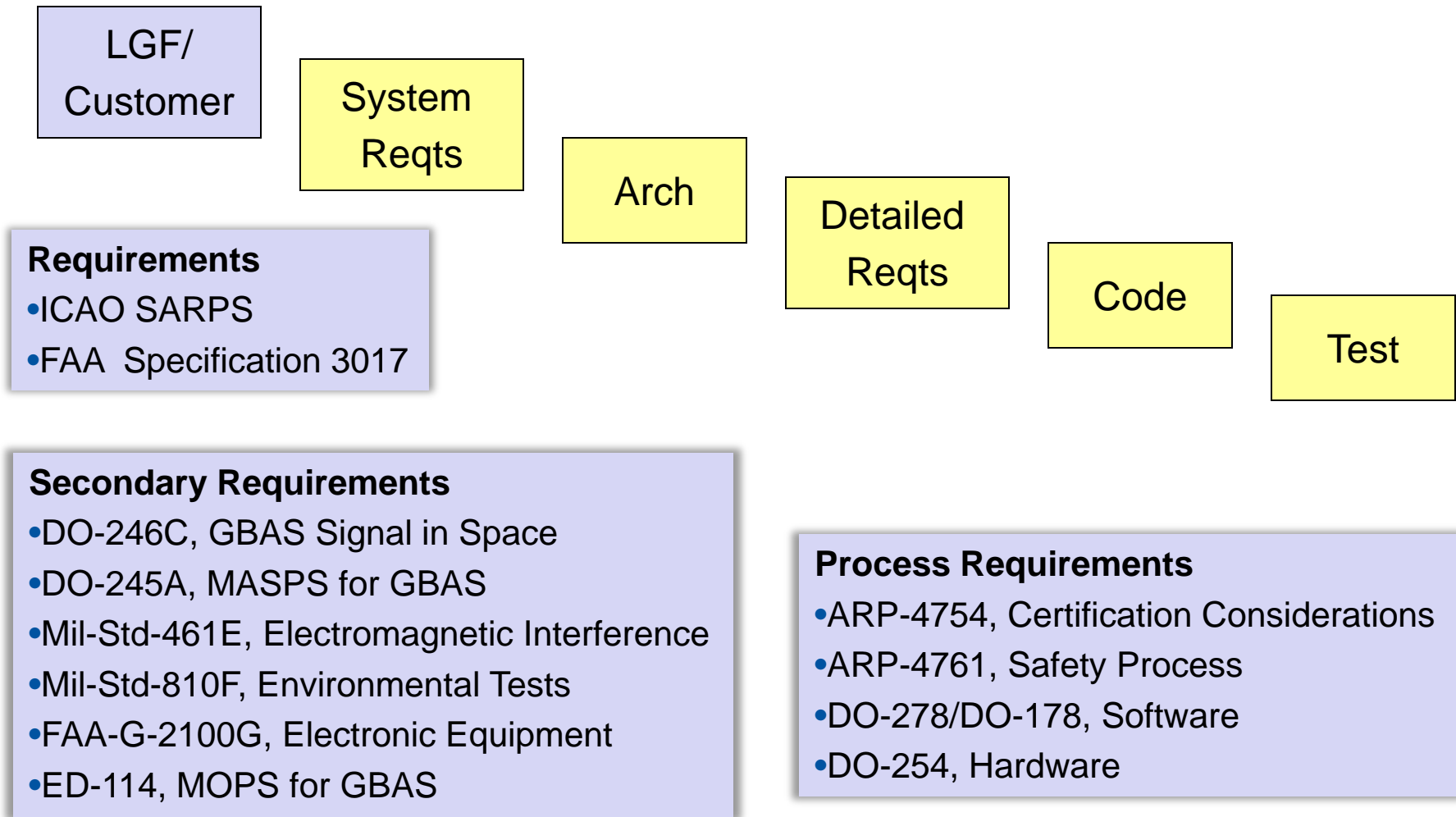
- Operations
- Maintenance
- Installation
- Flight Procedures
- Flight Inspection
- Spectrum Management
- Training
- Safety Management



SERVICE APPROVAL

- Aircraft Approval
- ATC Training
- Pilot Training
- Instrument Flight Criteria

Customer Requirements

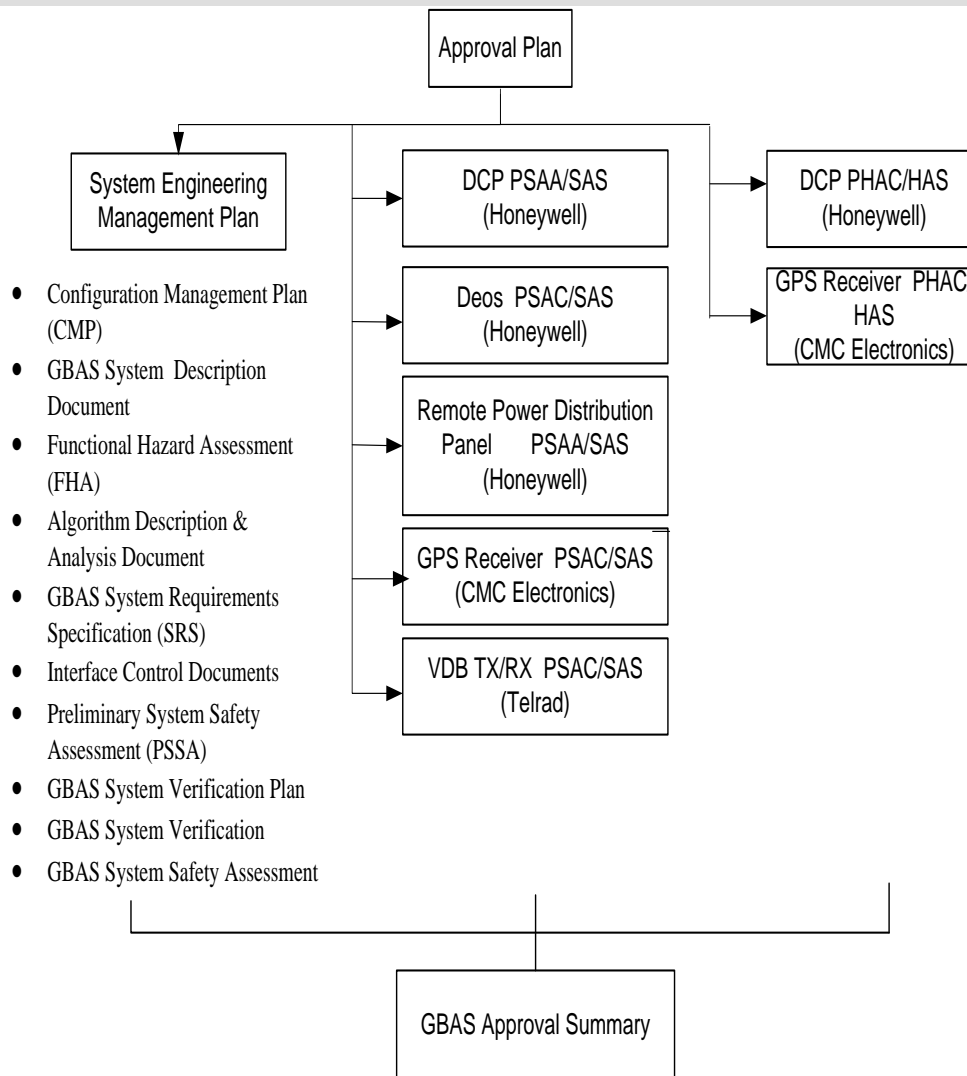


GBAS CAT I Approval Plan

- **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

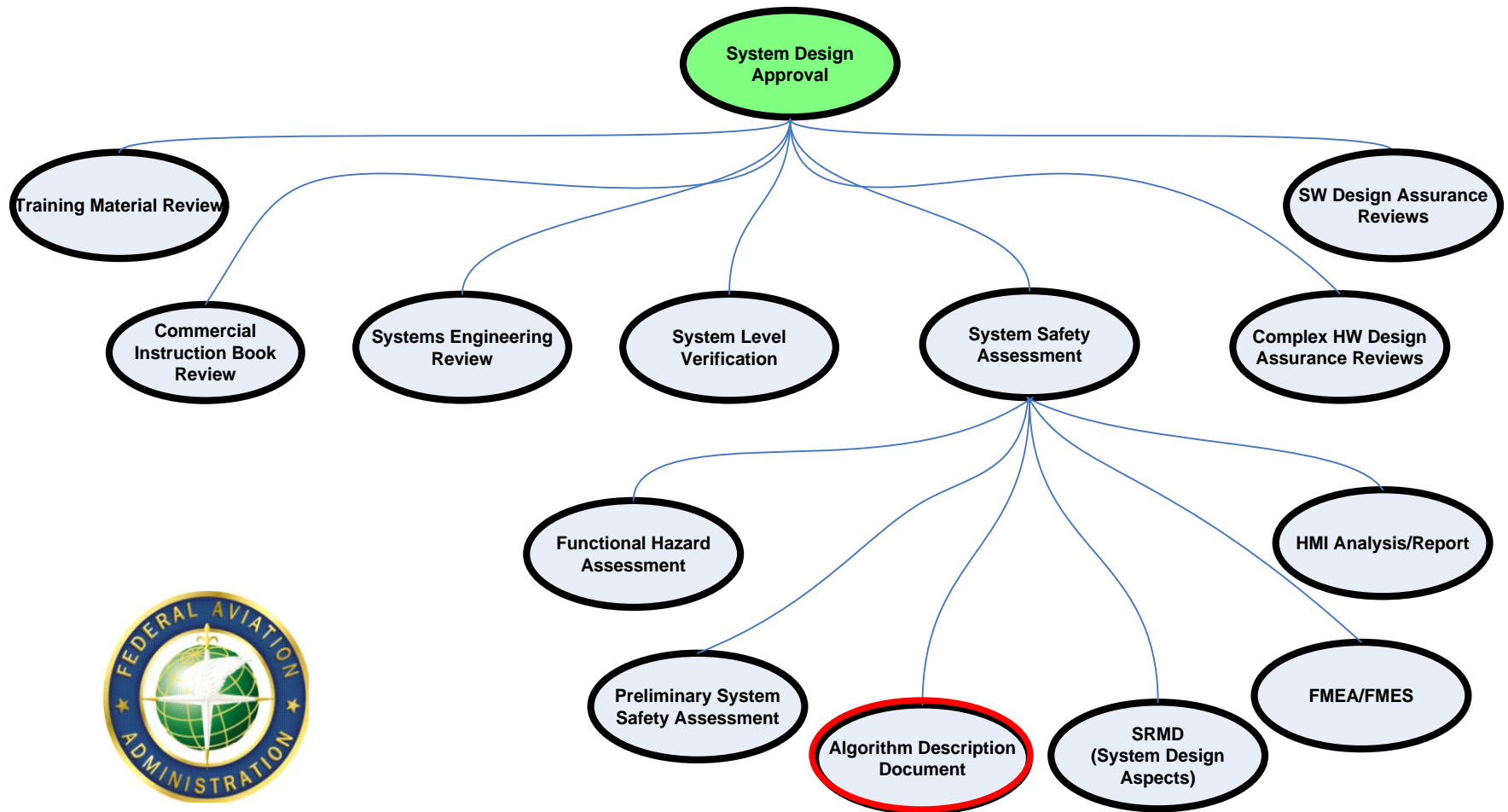
GBAS CAT I Approval Plan



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

FAA System Design Approval



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 – 1.5×10^{-7} in 150-seconds
 - Approach Integrity under fault free or no more than Reference Receiver fault – 5×10^{-8} in 150-seconds
- Minor Hazard Classification
 - Unscheduled interruption of VDB transmission (Loss of Continuity) – 1.0×10^{-6} in 15-seconds
 - Unscheduled loss of sufficient Reference Receivers or Ranging Sources (Loss of Continuity) – 2.3×10^{-6} in 15-seconds
- Availability – 0.99 (goal)

LAAS Integrity Panel

- **Purpose**

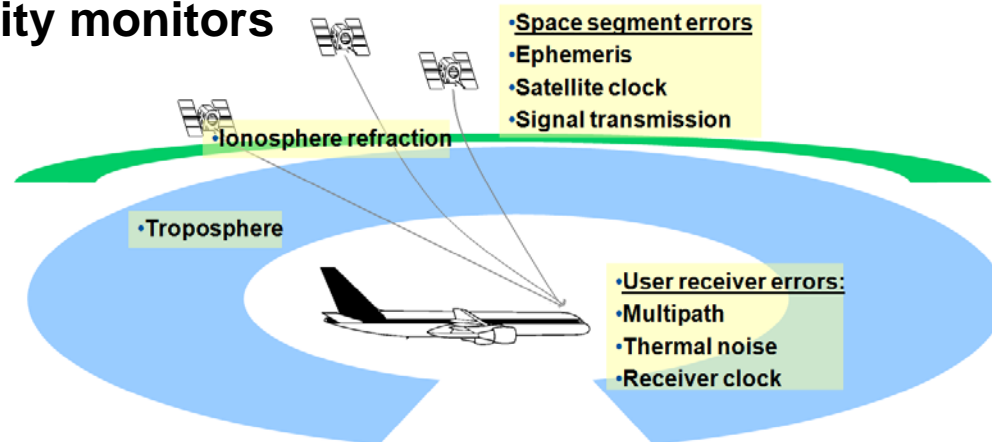
- Ensure GBAS integrity monitors address defined GPS threats

- **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



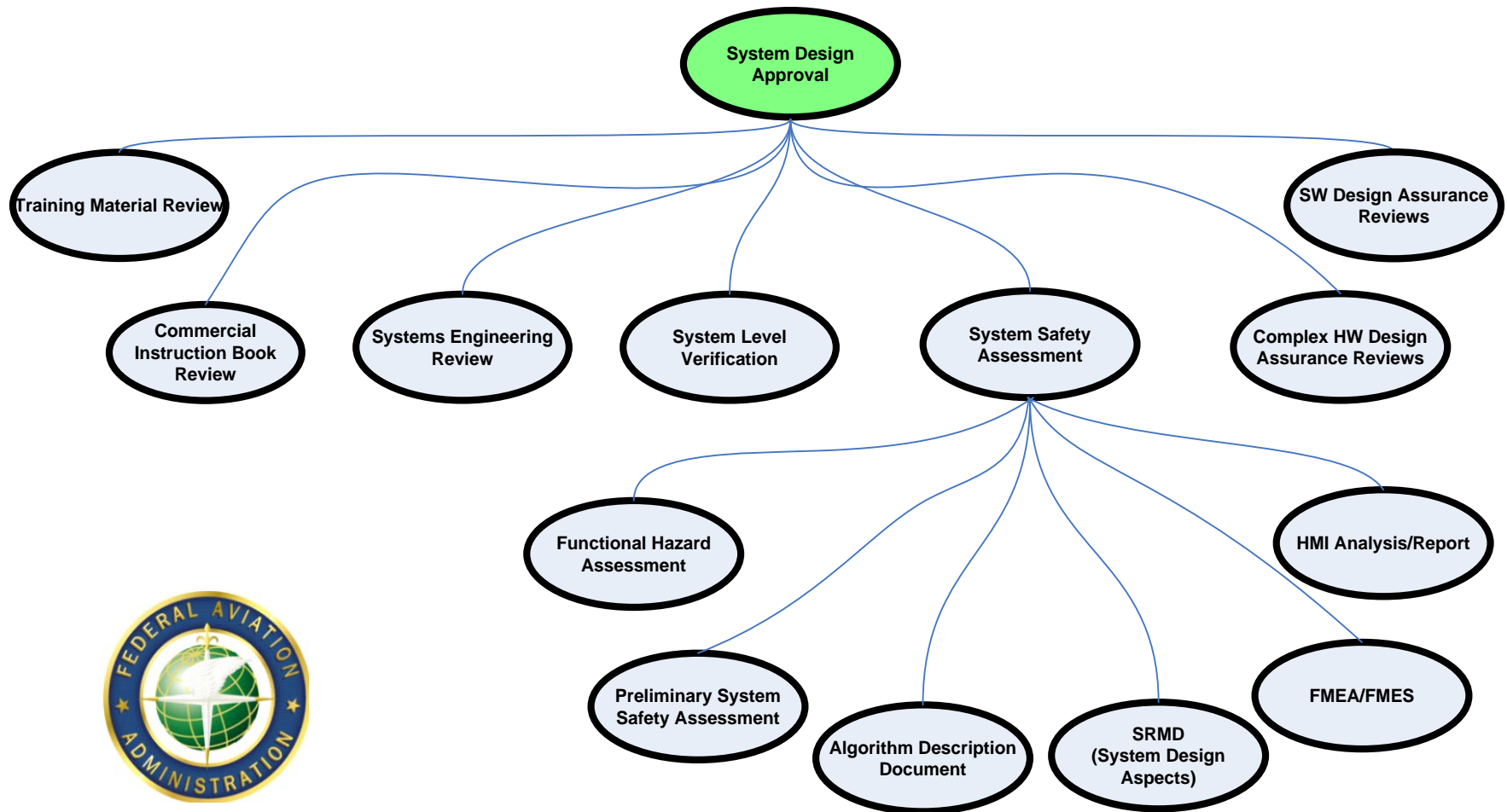
Integrity Algorithms

SCAT I	GAST-C	GAST-D	
SCAT I Operations (1998)	CAT I Operations	CAT I Operations	CAT II/III Operations
Broadcast Msg Type 1, 2 & 4	Broadcast Msg Type 1, 2 & 4	Broadcast Msg Type 1, 2 & 4	Broadcast Message Type 11
	Sigma PR Ground	Sigma PR Ground	
	Phase Center Non-Zero Mean	Phase Center Non-Zero Mean	
	Ground System Sigma Monitor	Ground System Sigma Monitor	
	Ionosphere Anomaly Monitor	Ionosphere Anomaly Monitor	
	Troposphere Anomaly Monitor	Troposphere Anomaly Monitor	
	Ephemeris Monitor	Ephemeris Monitor	
	Signal Deformation Monitor	Signal Deformation Monitor	
	Low Satellite Signal Power Monitor	Low Satellite Signal Power Monitor	
	Code Carrier Divergence Monitor	Code Carrier Divergence Monitor	
	Excessive Acceleration Monitor	Excessive Acceleration Monitor	Excessive Acceleration Monitor
	Executive Monitor	Executive Monitor	Executive Monitor
	RFI Above the Mask	RFI Above the Mask	
	Iono Screening Real Time Inflation	Iono Screening Real Time Inflation	
	Constellation Alerts	Constellation Alerts	
	Broadband RFI Monitor	Broadband RFI Monitor	
			Cross Correlation Monitor
			Iono Gradient Monitor

GAST-C provides foundation for GAST-D

**CAT III monitors
developed**

FAA System Design Approval





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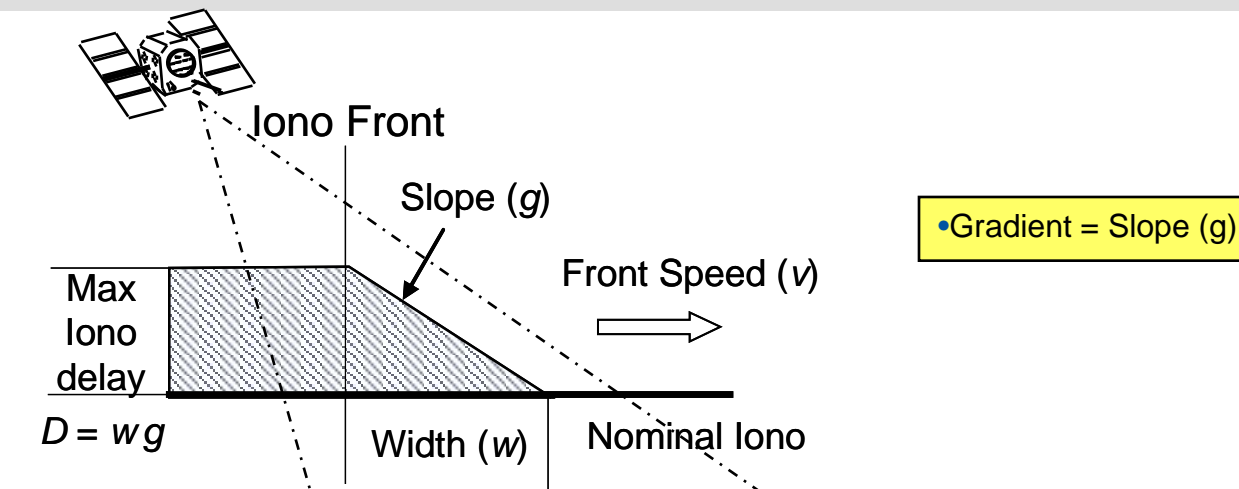
Ionosphere Mitigation

Honeywell

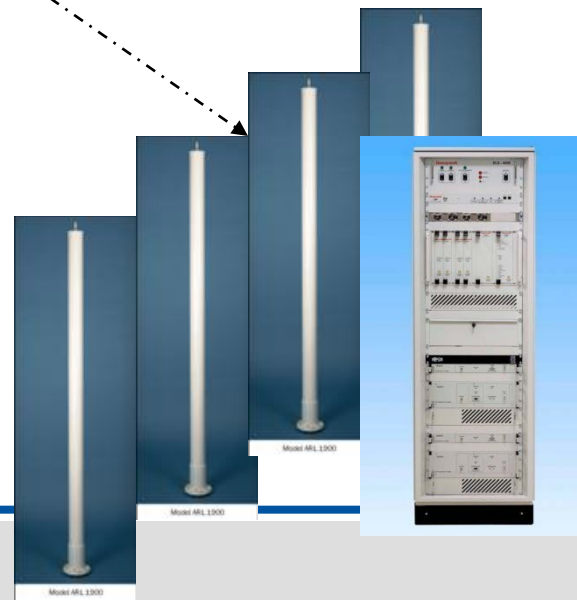
Ionosphere Threat Model

- **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

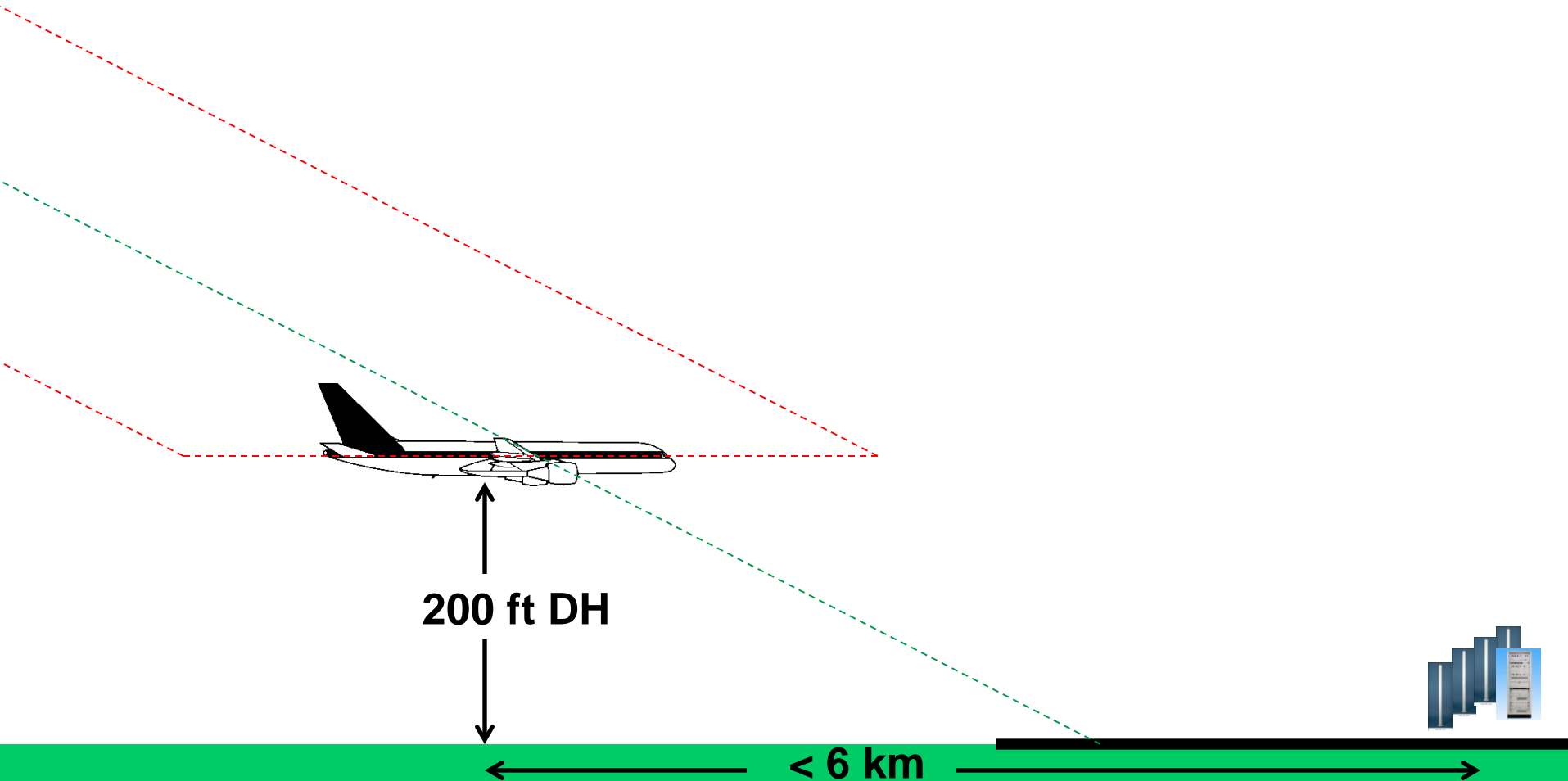
Rare Anomalous Iono



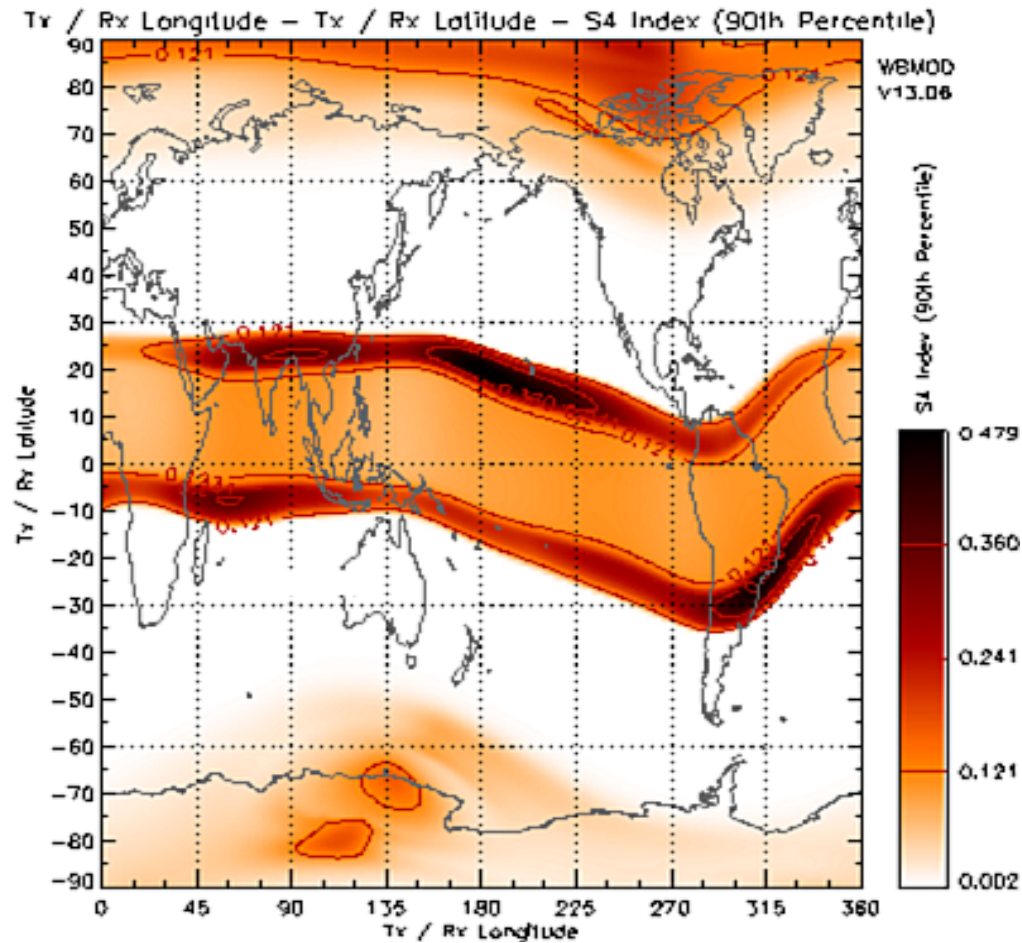
Results in integrity/position error



Iono Error at Decision Height



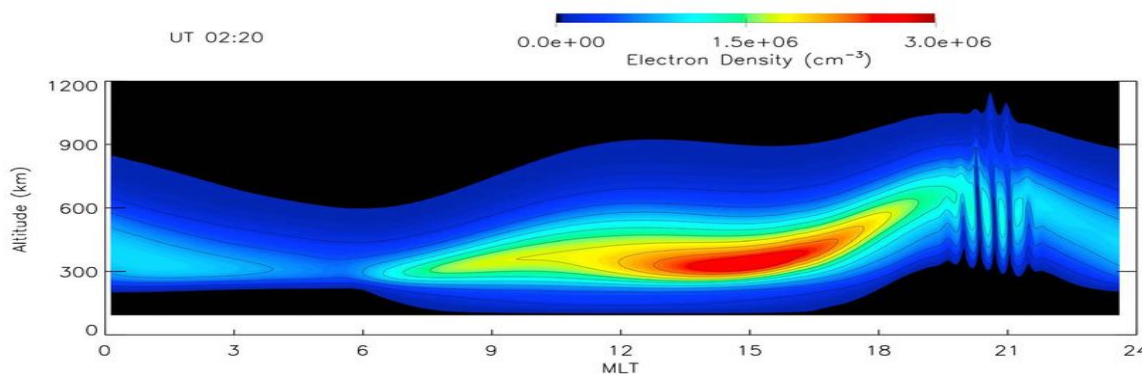
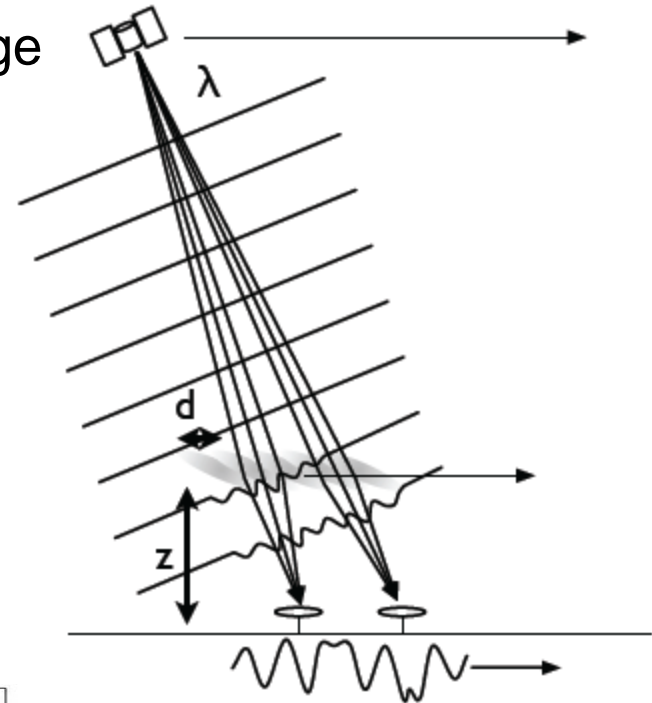
Iono Scintillation



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





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GBAS Approval by Country

Honeywell

Germany

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

Bremen



Frankfurt



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



Australia

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

Sydney



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

Zurich



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

Rio de Janeiro



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)

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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

