Embraer 170/175/190/195
and Lineage 1000 Update
Primus Epic FMS NZ 7.1, Load 23 and 25
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NZ 7.1 Overview

- **FMS software version NZ 7.1 (Load 23)**
  - Load 23.1 – compatible w/ Pentium II configurations
  - Load 23.2 – compatible w/ Pentium M configurations
  - Same software functionality – two (2) configurations

- **RNP ≤ 0.3**
- **Performance based sensors**
- **Enroute Holding Patterns**
- **Multiple Approaches of same type to runway**
- **VA/VI Leg Combinations**
- **Automated HA Sequencing**
Embraer Load 23 New Features

- Required Navigation Performance (RNP ≤ 0.3)
- Multiple RNP Approach Minima Type page
- Single RNP Approach Minima (< 0.3)
- PFD Present Position Determination Display
- GPS with SBAS (GPS-D) position sensor
- RNP/EPU Lateral Deviation Winglets (PFD)
- RNP Alerting
- CDI Slewing
- Takeoff/Go-Around (TOGA) Auto LNAV arm
- Engine out Standard Instrument Departure (EOSID)
- Automatic Dependent Surveillance Broadcast (ADS-B) Out
- Runway/Awareness & Advisory System (RAAS)
Quality Improvements
Quality Improvements

- **Localizer capture performance when no co-located DME**
  - Improvements to minimize beam capture oscillations
- **(AT) Auto-throttle FLCH synchronization below 10,000 ft**
  - Minimize airspeed overshoot during climb with FLCH
- **(GP) Guidance Panel (FD) Flight Director Button**
  - When source side FD is selected OFF with AP disengaged, FD modes are disengaged and AT reverts to **SPD on Thrust**
- **LNAV drop with no EICAS message**
  - ‘FD LATERAL MODE OFF’ CAS message displayed when LNAV disconnects after FMS flight plan discontinuity
- **New arming condition for (BC) Back Course mode**
  - Armed by pressing **NAV** or **APP** button on GP when appropriate
Quality Improvements

• **Spurious CAS messages during power-up**
  – AP FAIL, AT FAIL, AP FAULT, AT FAULT and AFCS FAULT inhibited during power-up PBIT

• **XPDR CAS message**
  – ‘XPDR 1(2) IN STBY’ CAS displayed in flight whenever transponder is in STBY mode

• **Waypoints missing on MFD**
  – Flight plan correctly displayed when true course between 359.9995-360 degrees

• **Weather Radar inadvertently transmitting on ground**
  – On ground logic prevents during warm-up period
Quality Improvements

• **New Cruise altitude and Speed tables**
  - FMS performance database based on Embraer tabular data
  - Optimum and Maximum cruise altitudes and cruise speeds match AOM data

• **Datalink message overflow after 255 reached**
  - Overflow corrected

• **Spurious EXCEED CEILING ALT scratchpad message**
  - Message inhibited

• **RTE page erroneous airway display**
  - Airways correctly displayed

• **What-If function erroneous calculations**
  - Perf data is correctly recalculated for cruise altitudes both above and below displayed altitude
FMS v7.1
Enhancements

Honeywell
Enroute Holding Patterns

- The FMS shall provide capability to utilize a database holding pattern in place of a default hold definition at an enroute waypoint.
- If the crew selects a hold at an enroute waypoint, the FMS will first determine if there is a database defined hold at that particular waypoint.
- If a hold exists, it will be entered into the flight plan as specified.
- If no database hold exists, the default hold definition will be inserted into the flight plan.
- If multiple patterns exist for a particular fix, they will be displayed on a page from which the desired pattern can be selected.
Multiple Approaches to Same Runway

- Multiple approaches with the same guidance (RNAV, LOC, etc.) to the same runway are annotated with an alphabetical suffix beginning at the end of the alphabet and working backwards for subsequent procedures.
- These multiple types will be added to the navigation database as they are defined and the FMS will provide these approaches for selection by the pilot.
  - Note: Most RNAV approach procedures will require RNP = 0.3.

- BENEFITS:
- Several approaches of the same type can be available for the same runway.
Multiple Approaches to Same Runway
Improve Heading to Altitude Flight Plan Legs

- Improve the guidance and sequencing for heading to altitude (VA) and heading to intercept (VI) leg combinations by using ground speed to compute the turning point onto the course
- Reduces unnecessary maneuvers
  - FMS will re-compute the intersection when the leg is active
VA-VI Combinations

**Take-Off Runways 1, 6:** Climb via heading 040° until reaching 1500 feet, then turn left direct PNJ NDB. Maintain 2000 feet until crossing the PNJ NDB, then climb and maintain 3000 feet. Thence...

**Intended path (dashed line [heading 040°])**

**Actual path controlled by FMS [heading overshoot to capture a course 040° from the 400 Ft point]**
Automated HA Sequencing

- Holding to Altitude (HA) legs are handled in a manner similar to VA legs
- If the aircraft has a current altitude that complies with the HA leg altitude constraint, the holding pattern will be deleted automatically by the FMS resulting in a VA leg
- An HA leg will sequence when the aircraft has achieved the HA altitude constraint
- FMS will perform an immediate exit of the holding pattern upon achieving the altitude constraint
- Altitude is provided by the navigation database when defined for SIDs, and missed approach procedures
Benefits: HA leg Auto Sequencing

• Currently the pilot has to perform a manual operation during a procedure that contains an HA leg. Implementation of this feature will enhance the automatic leg sequencing ability of the FMS.
Load 23 RNP Option
RNP Values

- Each leg of the RNP approach procedure can have different RNP requirements.

- The RNP values are stored in the aircraft navigation database.

- The RNP values change as the aircraft is flown past the associated waypoints on the approach up to the final approach segment.
RNP Minimums Selection

- Select the desired RNP value by pushing LSK 1L, 2L or 3L (up to three minima can be available)

- Select RETURN (LSK 1R) to return to the ARRIVAL page
RNP Minimums Selection

- Select an RNAV RNP approach on the ARRIVAL page

- Select RNAV MIN (LSK 2R) if necessary
  - The default RNP value is associated with the lowest approach minimums
RNP Minimums Selection

- Select INSERT (LSK 6R) to insert the approach into MOD RTE/FLT PLAN or REVIEW (LSK 6L) to review the procedure.
Multiple/Single RNP Minima Values

- RNAV (GPS/RNP) Load 21
- RNAV (GPS) Load 23
- RNAV (RNP ≤0.3) Load 23

*When using RNP <0.3, the RNP minimum change of the waypoint prior to the FAF and not necessarily at the initial Fix (IF).*
Active RNP Value Display

• The active RNP value is displayed on the PFD and PROGRESS page

• The priority of the active RNP value is determined as follows:
  – Pilot entered manual RNP value
  – The RNP value from the navigation database
  – Pilot entered flight-phase RNP value
  – Default flight-phase RNP value
Present Position (PPOS) Determination Mode

- Navigation mode the FMS is currently using is displayed in magenta above the FMS mode annunciators.
- Displayed on PFD and PROGRESS page 1.
- GPS-D is GPS Differential Navigation Mode.
GPS Differential Mode (SBAS)

- DIFFERENTIAL mode is displayed when SBAS capable GPS unit is installed and SBAS is available.
- Utilizes SBAS corrections for enhanced position accuracy.
RNP/EPU Lateral Deviation Winglets

• EPU (Estimated Position Uncertainty) is the calculated estimate of the accuracy of the navigation equipment aboard the aircraft
  – A textual display of the EPU value is displayed on the PROGRESS page on the MCDU
  – A new graphical representation of the EPU value is displayed on the PFD as winglets on the lateral deviation scale

• The winglet attached to the lateral deviation pointer diamond represents the current estimated position uncertainty (EPU) as an error bar

• The second dot on each side of the center tick mark represents the current RNP setting (first dot equals ½ current RNP setting)
RNP/EPU Lateral Deviation Winglets

- The winglets are removed from the display when the EPU values are within the open diamond.

- As EPU increases, winglets expand outward.

- When EPU exceeds RNP, the scale and lateral deviation pointer diamond with winglets change to amber, flash for 5 seconds then are steadily displayed in amber.

*On Course with Winglet at Second Dot (EPU = RNP)*
RNP/EPU Lateral Deviation Winglets
RNP Alerting

• When the winglet exceeds 1XRNP, the lateral deviation pointer is parked at the side of the scale.

• The lateral deviation pointer and scale change to amber, flash for 5 seconds then are steadily displayed in amber.

*Off Course with Winglet beyond Second Dot = AMBER*
RNP Prediction

- When the aircraft position is within 2 minutes of a waypoint, the FMS reviews the RNP value for the next flight plan leg and compares it with the current EPU.

- If the EPU is greater than the compared RNP value, the message UNABLE RNP NEXT WPT is displayed on the scratchpad.

- The next flight plan leg RNP value is as follows:
  - The manual RNP value (when entered)
  - The database RNP value (when present) or
  - The RNP value based on phase of flight
CDI Slewing

- The CDI remains centered during waypoint transitions (course turns between waypoints)

- Current logic sets CDI to the new course with resulting CDI off-course indications

- Alleviates off-course indications during approach waypoint transitions
Load 23 Additional Options
Auto LNAV for TOGA

- Automatically transitions from ILS approach guidance to FMS missed approach guidance when selecting TOGA
  - Remains in FMS, if FMS approach guidance

- Pilot will not need to engage LNAV during MAP, LNAV will automatically ARM for engagement upon selecting TOGA

_Simplifies cockpit procedures & reduces pilot workload_
A modified departure procedure that can be activated into the flight plan after an engine failure

EOSIDs are airline specific and must be defined in the company database

After the departure runway is selected, the EO SID prompt is displayed on the SIDs page if an EOSID is available
The EO SID can be previewed by selecting the EO SID check box button on MAP and PLAN menus.
• After in-flight engine failure the EO RANGE page is displayed

• Flight crew confirms engine-out by selecting LSK 5R that changes the SELECTED ENG MODE to EO
EOSID

• The EOSID is automatically inserted into the flight plan as an EO MOD FLT PLAN and displayed on the MFD when:
  – EOSID condition has been confirmed
  – An EOSID exists for the departure runway
  – The aircraft is within 50nm of the origin or actively flying a departure

• Since the entire EOSID is inserted into the flight plan, it is the flight crew’s responsibility to confirm the flight plan prior to activation
(ADS-B) Out

Honeywell
(ADS-B) Out

- Automatic Dependent Surveillance – Broadcast
- Transponder function that provides broadcast data with respect to the aircraft position, aircraft state data, and aircraft vector data of high frequency and accuracy over 1090MHz
(ADS-B) Out

- ADS-B is selected on the TCAS/XPDR page 1/2
• When ADS-B is invalid, ADS-B is displayed in amber
RAAS
(Runway Awareness & Advisory System)
Honeywell
Overview

- What constitutes a Runway Incursion
- RAAS system overview
- RAAS Operations
- Routine Advisories
- Non-Routine Advisories
- RAAS Options
Runway Safety

NTSB (September 13, 2005) Acting (NTSB) Chairman Mark Rosenker Speaking before the runway and airport safety summit of the American Association of Airport Executives, Dulles, Va.

– Warnings of impending runway incursions need to go directly to pilots & air traffic controllers

– Airport Movement Area Safety System (AMASS) is "not adequate" to prevent serious runway collisions because of its operational limitations and the fact that it provides warnings, when it does work, to controllers but not to pilots.
What Defines a Runway Incursion?

- A runway incursion is an occurrence in the runway environment that either creates a collision hazard or loss of required separation.

- Surface incidents can include conflicts between aircraft and other vehicles, obstacles and/or pedestrians in the taxiway or ramp areas. This category also includes inadvertent landing or takeoff on taxiways.
Some Causes for Runway Incursions

- The rate of incursions go up with the number of airport operations
- The busier the airport the more you can expect an incursion
- Besides the number of airport operations, there are other factors that contribute to runway incursions:
  - ATC operational errors and deviations (loss of separation with aircraft on final with an aircraft cleared into position and hold)
  - Vehicle/Pedestrian Deviations (mechanic moving aircraft without ATC clearance)
  - Pilot Deviations (crossing a runway during taxi without clearance)
If we look at the FAA data again, we can see that from 1999 to 2002 that Pilot Deviations made up over 50% of the incursions.

Introduction to RAAS

• RAAS (Runway Awareness and Advisory System) was developed in response to the industry’s and governments concern with runway incursions and approach and landing accidents.

• Although RAAS alerting primarily protects against runway incursion scenarios, it also provides some additional protection for runway overruns such as:
  – Landing on short runways
  – Intersection takeoffs
  – Distance to go during landing and RTO
Introduction to RAAS

- RAAS looks at incursion risk relative to runways
- Does not alert the crew to taxiway boundary incursion
- Development influenced by:
  - Concern that crews should not be “heads down” while moving on the airport surface
  - Lack of good airport data
  - Use of Honeywell’s highly accurate and validated proprietary database
  - Leveraging off of existing hardware/software that passes the savings to the customer
Introduction to RAAS

- When incident/accident data was investigated, 4 incursion scenarios had a high frequency of occurrence
  - Taxiing across an active runway without a clearance
  - Simultaneous approaches to the same runway
  - Lining up on the wrong runway for takeoff or landing
  - Simultaneous takeoff or landing on intersecting runways
About RAAS Aural Advisories

- The RAAS messages were purposely timed and constructed to be short, to minimize impact with ATC communications.

- The volume for the RAAS aural messages is controlled by the EGPWS computer. The pilot does not have control over volume level.

- However, the computer will vary volume depending on the particular message and its priority.
About RAAS Aural Advisories

• The RAAS aural advisories are heard over the same aircraft audio systems as the EGPWS aural alerts

• RAAS Advisories are mutually exclusive. In the event that more than one advisory is triggered at the same time a message priority scheme has been implemented
About RAAS Aural Advisories

• In the event of multiple concurrent RAAS advisories, the EGPWC will issue the alerts in the following order;
  – Approaching Runway In-Air
  – Approaching Short Runway In-Air
  – On Runway
  – Insufficient Runway Length On-Ground
  – Approaching Runway On-Ground
  – Taxiway Take-off (Note that Taxiway Take-Off advisory is the only RAAS advisory that can interrupt another RAAS advisory. On-Taxiway advisories do NOT interrupt other EGPWS cautions and warnings, only other RAAS advisories)
  – Extended Holding
  – Runway End
RAAS System Overview

- RAAS - is a software enhancement that is hosted in the EGPWS unit

- RAAS - software works with EGPWM (Sovereign) Honeywell MK V (Citation X) or MK VII

- RAAS - uses GPS for aircraft position and the EGPWS database to provide crew situational awareness on the ground while taxiing and on short approach

- RAAS - when enabled does not require any action from the crew. RAAS will automatically provide the crew with aural advisories
RAAS System Overview

• **RAAS System Requirements**
  - Honeywell EGPWM, MK V or MK VII EGPWC
  - The EGPWS unit must have a GPS source
  - A RAAS configuration database
  - An EGPWS database version 435 or later
  - Version of 218-218 software or later with a RAAS enable key
  - Or version 965-1690-051 or later with a RAAS enable key

• **RAAS is not compatible with earlier versions of the EGPWS software or terrain database**

• **RAAS availability can be verified by performing an EGPWS self test**
RAAS System Overview

• The RAAS system takes advantage of the existing EGPWS technology

• The system requires a software upgrade ONLY and presents the audio alerting messages over the aircraft’s existing audio system

• Additional hardware, wiring, switches, or displays are NOT required

Separate EGPWS box (non-Epic)
Terrain Database

- **In-house Proprietary Database**
- **Compiled from multiple sources**
  - Military DMA data
  - Space Shuttle Topography Data
  - USGS Topographical Data
- **Contained on PCMCIA card**
  - Loads in approximately 25 minutes
  - Compressed data resident in EGPWS flash memory
- **Updates are irregular, not required, but recommended**
Airport Runway Database

- **World-wide Airport (Runway) database**
  - 12,000+ airports worldwide, 30,000+ runways
  - Hard surface 3500 feet (or 3200 feet in some EGPWS)
  - Look-ahead algorithm processes the contents of the database into nearest runway center position, nearest runway threshold position, and nearest runway altitude for use by the EGPWS
  - We will add custom/private runways upon request (free)
RAAS Operations

• The system ‘knows’ the aircraft position, the aircraft’s track/heading, and groundspeed
• And importantly, from the runway database, it knows all the runways at the departure airport, including the runway dimensions
• The runway logic algorithms then determine the appropriate alert sequence and timing
• For any given groundspeed the logic will increase the alert distance to pad the pilot’s reaction time
RAAS Operations

- RAAS is powered ON when aircraft power is applied
- There is no Power ON/OFF switch
- RAAS audio messages come through the aircraft’s audio system (overhead speakers or headphones)
- Volume cannot be controlled from flight deck but is pre-set at installation
- RAAS alert messages cannot be turned on or off by the crew
- There is no action on the part of the crew to enable the messages (they are completely controlled through software)
RAAS Operations

- A preflight functional test of RAAS can be performed on the ground only
  - Maintenance can perform a Self Test Level One from the EE bay
  - AND/OR the crew can perform a RAAS operation quick check in the cockpit

- To perform a quick cockpit check of RAAS
  - Select TERR on the MCDU
  - Run the range up or down one ‘click’
  - The text message “RAAS - OK - FT” (or METERS) will be seen on the second or third sweep indicating an airworthy RAAS system
Routine Advisories

• There are 5 Routine Advisories

• 3 advisories will be heard regularly by the flight crew
  – “APPROACHING 17L” (on ground)
  – “ON RUNWAY 17L” (lining up for takeoff)
  – “APPROACHING RUNWAY 17L” (on approach to landing)

• 2 routine advisories may or may not be heard
  – “4000 REMAINING” “3000 REMAINING” (distance remaining)
  – “100” (runway end advisory)
RAAS Non-Routine Advisories

1. Approaching Short Runway - In Air Advisory
   ➢ “APPROACHING 34R” “THREE THOUSAND AVAILABLE”

2. Extended Position and Hold
   ➢ “ON RUNWAY 35R” “ON RUNWAY 35R”

3. High Taxi-way Speed
   ➢ “ON TAXI-WAY” “ON TAXI-WAY”

4. Intersection Takeoff - Insufficient Runway
   ➢ “ON RUNWAY 18R” “TWO THOUSAND REMAINING”

5. Rejected Takeoff
   ➢ “4000 REMAINING” “3000 REMAINING” “2000 REMAINING”
Enhanced Ground Proximity Warning System - Honeywell Aerospace - Microsoft Internet Explorer

MK V and MK VI EGPWS software - 220-230 with SmartRunway and SmartLanding functions receive FAA TSO-C161a authorization. Please visit our Runway Safety website.

MK III and MK X helicopter EGPWS receive FAA TSO-C194 HTAWS authorization. Please visit our Helicopter EGPWS webpage.

Honeywell pioneered the first Terrain Awareness and Warning System (TAWS) over 30 years ago. Today, we offer enhanced TAWS protection in our “EGPWS” for thousands of airliners of all types around the world. TAWS is already credited with 33 documented aircraft saves, including the first helicopter I database save with our MK X.

General Information

EGPWS uses aircraft inputs such as position, altitude, air speed and glideslope, weather data, and internal terrain. Therefore, what alert is generated depends on the aircraft’s flight path and terrain or obstacles.

Products

Learn more about the unique capabilities and features of the various EGPWS models.

Database

Update your database to the latest version, search for a specific airport, or download a list of all airports included in the database.

SmartRunway / SmartLanding / RAAS

Honeywell’s SmartRunway (formerly RAAS) and SmartLanding provide improved situational awareness to help lower the probability of runway incursions and excursions by providing timely and relevant advisories to the flight crew during taxi, takeoff, final approach, landing, and rollout.

Access installation and design guides, interface control documents, customer installation worksheets and more.

Honeywell Proprietary
Load 25 Improvements
Load 25 Improvements

• **FMS Position Anomaly**
  – Prior to Load 25, Large IRS bias was caused by a normalization anomaly when computing the difference between FMS longitude and IRS longitude when crossing the 180 degree Meridian Line

• **RWY Change and no Arrival Inserted**
  – Prior to Load 25, when no arrival or approach procedure was loaded and a change to another runway was selected, the MOD FLT PLAN was created with incorrect information
  – The new runway is depicted as the FROM waypoint and the aircraft disconnects from LNAV and goes into ROL mode
  – EMB OB-170-001/10 contains detailed information

• **Updated performance database tables**
• **FMS Autotune Updates**
Load 25 Improvements

- **FD VERT MODE OFF during ILS**
  - Load 23 introduced a modification in the glide slope signal monitoring that may result in vertical flight director mode dropping off below 100 ft AGL during ILS operations
  - Consequently, prior to touchdown, FD VERT MODE OFF may be displayed on EICAS
  - Issue resolved in Load 25
Missed Approach Profile Activation

- Prior to load 25, the only way to activate the lateral profile of the missed approach is by pressing the TOGA buttons on the thrust levers.
- A MISSED APPR prompt is now available on the MISSED APPROACH page and the FLT PLAN page.
Steep Climb

- Current FD logic is limited to 18 degrees pitch during climb
- New FD logic which can guide up to 25 degrees in TO mode
- Can be used to comply with noise abatement procedures
CPDLC
CPDLC

- PM-CPDLC (Protected-Mode Controller Pilot Datalink Communication)
- Uses VDL Mode 2 (VHF digital data link) provided by ARINC or SITA ground stations
  - Higher speed and integrity than traditional VDL Mode 1 (ACARS) data communications
- Complies with Link 2000 European Mandate
CPDLC

- Can be accessed by any MCDU using the DLK key
- Once accessed, only 1 MCDU can perform datalink functions

- Message uplinks are depicted by visual indication on PFD and MCDU as well as aural advisory
CPDLC

• Data communication between aircraft and ATC
  – ATC Requests
  – ATC Reports
  – ATC Uplink / Downlink Messages
CPDLC

- Data communication between aircraft and ATC
  - ATC Requests
  - ATC Reports
  - ATC Uplink / Downlink Messages
• Example: Speed request
  – Enter requested speed
  – Select reason for request
CPDLC

- **Verify page**
  - Press SEND after verifying message request is correct
CPDLC

- **ATC Uplink Messages**
  - Messages received from ATC show up in Message page and Message Log Page
  - Crew responds with WILCO, UNABLE, or STANDBY