

Factual Report – Attachment 10
Horizon Air Q400 RNAV Approach Guidance

OPERATIONAL FACTORS/HUMAN PERFORMANCE

DCA18IA081

NOTE:

Vertical deviation (VDEV) in feet can be observed on FMS NAV page 1/4.

Authorized RNP Minimums

The Q400 is authorized for RNP approach operations to the RNP 0.10 line of minima (see example below).

TERPS		STRAIGHT-IN LANDING RWY 10R	
		RNP 0.10 DA/H: 346' (323')	RNP 0.30 DA/H: 448' (425')
		ALS out	ALS out
A			
B			
C	RVR 32 or $\frac{3}{8}$	RVR 50 or 1	RVR 50 or 1
D			1 $\frac{3}{8}$

Altimeter Setting and Crosscheck

RNP approach operations require the use of barometric VNAV for glidepath guidance to minima (DA). Since the accuracy of the glidepath provided by baro-VNAV is dependent on the accuracy of the barometric setting of each primary altimeter, it is essential the flight crew ensures the current altimeter setting is set no later than the FAF. After the current altimeter setting for the approach has been set:

- As the aircraft crosses over the FAF the PM shall conduct the instruments and altitude crosscheck.
- If the altitude crosscheck between the two primary altimeters exceeds 100 feet, a missed approach shall be executed unless visual reference to the runway environment has been established and the aircraft is in a position to allow the safe continuation to a landing.

Missed Approach Requirements

Unless the visual references required to continue to the intended runway have been acquired, a missed approach shall be initiated if:

- Lateral deviation exceeds ± 2 dots.

NOTE:

Momentary full scale deflection of the CDI needle associated with a waypoint crossing that includes a course change or a reduction in RNP does not require an immediate missed approach, provided the aircraft acquires the new course in an appropriate manner.

- Vertical deviation during the final approach segment (FAF to MAP) exceeds 75 feet above glidepath or 50 feet below glidepath.
- The altitude between the two primary altimeters exceeds 100 feet as the aircraft crosses the FAF.
- A missed approach is required if any of the following appear on the PF FMS or PFD and are not resolved by the FAF:
 - NAV flag
 - POS (position uncertain message)
 - GPS INTEG message
 - No RAIM @ FAF
 - No RAIM @ MAP
 - FMS is not in Approach Scaling
- Loss of Flight Director
- Loss of autopilot when using minimums less than RNP 0.30.

Company Approach Out-of Service NOTAMs

Prior to initiating an RNAV approach, a check of the applicable portions of the weather packet shall be conducted to ensure the approach procedure is not listed Out-of-Service via a Company NOTAM.

- With WAAS capability, the UNS-1Ew is approved for primary means of navigation. If all available WAAS sensors in the UNS-1Ew FMS are inoperative, the aircraft shall have approved navigation equipment appropriate to the route of flight installed and operating so as to provide an alternate means of navigation.
- Whenever navigation is predicated on the FMS, the applicable Universal Operator's Manual covering software version 1000.X (or equivalent at current revision) shall be available to the flight crew.

NOTE:

The Q400 FSM satisfies this requirement.

- The UNS-1Ew shall utilize software part number SCN-1000.3 or SCN-1001.1. The same software part number shall be installed in both FMSs.
- Fuel display parameter is advisory only and shall not be used as the primary means for computing fuel load and range.
- The FMS may only be used for navigation guidance if the reference coordinated data system for the intended route is referenced in WGS-84 or NAD-83.

Enroute

- IFR enroute and terminal navigation is prohibited with the FMS database expired unless the pilot verifies the waypoints for accuracy by reference to current publications.
- When using previously-stored flight plans and waypoints, the waypoints shall be verified for accuracy, by reference to current publication, prior to their use.

VNAV

- VNAV vertical path angles greater than 6° in enroute and terminal mode and greater than 4° in approach mode are prohibited.
- When the altimeter is adjusted to display height above ground (QFE) rather than sea level, use of Barometric VNAV is prohibited.

Approach

- Approach navigation is prohibited with the FMS database expired unless established procedures are followed. (See Validation of Procedures with Out-of-Date FMS Database – Approach Operations, in FOM section 2, Policy.)
- Instrument approach procedures shall be retrieved from the FMS database and shall be accomplished in accordance with the published procedure. The pilot shall verify waypoints for accuracy by reference to current publications.
- Instrument approaches shall be conducted with the FMS in approach (APPR) scaling.
- GPS approaches shall have RAIM available at the final approach fix.
- FMS-based ILS and MLS approaches are prohibited.

NOTE:

Applies to ILS final segment only.

- The use of pilot-defined approaches under Instrument Meteorological Conditions is prohibited. Pilot-defined, non-published approaches shall be flown in Visual Meteorological Conditions (VMC only.)

RNAV (RNP) Approaches

- The UNS-1Ew FMS is approved for RNAV (RNP) approaches to an RNP level of:
 - With Flight Director, 0.30 nm for approach,
 - With Autopilot, 0.10 nm for approach, and
 - Less than 1.0 nm for missed approach.

- Radius-to-Fix (RF) legs are approved.
- The DME sensor shall be deselected on each FMS prior to initiating an RNAV (RNP) approach.
- RNAV (RNP) approach requires the following equipment to be operative:
 - Two UNS-1Ew FMSs
 - Two WAAS sensors
 - IRS
 - EGPWS
 - Flight Director
 - Autopilot (RNP less than 0.30)

RNAV (GPS) Approaches to WAAS LPV Minima

- The UNS-1Ew is approved for RNAV (GPS) approaches to published LPV minima provided the LPV Level of Service (LOS) light on the PF side FMS is illuminated.
- LPV precision approach capabilities require two operational FMS. This provides the ability for cross-monitoring critical functions which are used during LPV approaches and ensures the accuracy and integrity of the WAAS system.
- If dissimilar LOS between the FMSs is annunciated, the approach may be continued to the published minimum using the highest LOS available. The LOS flight guidance to be used must be displayed on the PF PFD. If the approach is coupled, the same FMS providing flight guidance to the PFD for the PF must be used for the autopilot.

NOTES:

- *The highest LOS referenced above means the best level of navigation performance available from the FMS and normally equates to the lowest minimums available on an RNAV approach chart. The three levels of service available from the FMS listed in descending order (best to worst) are: (1) LPV, (2) LNAV + VNAV, (3) LNAV.*
- *If the highest LOS is displayed above the PM's FMS and those minimums are required, aircraft control and HSI SEL guidance should be transferred to the PM, if practical.*

Enhanced Ground Proximity Warning System (EGPWS)

1. Pilots are authorized to deviate from their current air traffic control clearance (ATC) to the extent necessary to comply with an EGPWS warning.
2. Navigation must not be predicated upon the use of the Terrain/Obstacle Awareness Display on the MFD.

NOTE:

The Terrain Obstacle Awareness Display is intended to serve as a situational awareness tool only, and may not provide the accuracy and/or fidelity on which to solely base terrain avoidance maneuvering.

FMS Power Down

The proper method to turn the FMS off is to use the FMS's own shutdown procedure. It is important to shut the FMS down properly before DC power is removed to the FMS. If DC power to the FMS is removed prior to shutting it down, it is perceived as a power failure which could have numerous adverse consequences, including improper operation upon the next startup.

The FMS should always be powered down as follows:

1. Press the ON/OFF/DIM button. (The dimming control window will be displayed.)
2. Press OFF (R5)
3. Press CONFIRM OFF (R1)

The FMS will enter a programmed shutdown sequence, after which it will power down.

RNP Approach Overview

(The following meets FAA documentation requirements for RNP)

Although many aspects of an RNAV (RNP) approach look the same and are conducted in the same manner as all other FMS approaches, there are some unique qualities that set RNP apart from other FMS Approach types. As a result of these qualities, it is important there is a full understanding of the unique requirements and limitations applicable to RNP approach operations.

Required Equipment

There is specific equipment that shall be operational to conduct RNP approach operations. For pre-Dispatch planning, the applicable MEL will provide guidance regarding RNP approach operations for inoperative equipment. For in-flight reference, the Emergency & Abnormal Checklist will provide applicable guidance for equipment that fails while enroute. The required equipment for RNP approach operations is listed below:

- Two operational FMSs
- Two operational WAAS sensors
- IRS
- EGPWS
- Flight Director

Use of Flight Director is required for all RNP approaches.

- Autopilot (RNP <0.30 only)

Use of autopilot is required for approaches when using lines of minima less than RNP 0.30.

Deselecting DME Sensors for RNP approaches

The DME sensor shall be deselected on each FMS prior to initiating a RNP approach. This will ensure, in the event of a WAAS sensor failure, the FMSs will default to the IRS sensor for navigational guidance during a missed approach.

To deselect the DME sensor:

- Select: DATA>DATA>DME(R3)>DESEL DME(R4).
- The DME sensor will automatically reset on both FMSs on landing.

NOTE:

For FMS with SCN-1001.1 software, the FMS will automatically deselect DME when an RNP approach becomes armed or active. In this case the crew will only need to verify DME has been deselected.

Maximum Airspeeds, Curved legs (RF Legs)

Since the ability for an aircraft to remain on the centerline of a Radius-to-Fix (RF) leg is primarily a function of speed, bank angle, and turn radius, it is necessary to apply speed limits to RF legs. Maximum speeds are predicated on standard design criteria used for establishing the width of protected airspace and an aircraft's ability to navigate the lateral course.

Some approaches may have charted maximum speeds associated with a specific segment of that procedure. Charted speed limits are published to accommodate unique design requirements for that approach. The following guidance for speed limits applies to RF legs:

- When a speed limit is published on an approach chart the published speed limit is controlling.
- When a speed limit is not published on an approach chart, standard speed limits apply (see table below for standard speed limits).
- Published speed limits may be either slower or faster than standard speed limits.
- Air Traffic Control cannot issue and a pilot may not accept a speed constraint greater than the controlling speed limit for an approach.

NOTE:

Maximum speed limits may not be waived by ATC.

- Speed limits published on an approach chart may be given as either Indicated Airspeed or Ground Speed.
- Standard speed limits are always given as Indicated Airspeed.
- Speed limits should be considered as being the maximum authorized under good conditions.
If there is any question regarding the aircraft's ability to remain within the lateral bounds of protected airspace on a curved leg, aircraft speed should be reduced.
- The aircraft shall be at or below the applicable speed limit prior to crossing the waypoint that defines the beginning of the RF leg.
- If approach Category D speeds are used for any portion of an RF leg within the final segment of an approach, CAT D minimums (DA) shall be used.

Standard Speed Limit Table – RF Legs		
Approach Segment	CAT C	CAT D
RF legs in Initial & Intermediate	240 kts IAS	
RF legs in Final	140 kts IAS	165 kts IAS
RF legs in Missed Approach (MAP to Missed Approach Hold Point)	240 kts IAS	

Track Deviation Monitoring

Due to the reduced obstacle clearance for RNAV (RNP) approaches, close adherence to the depicted lateral and vertical track centerlines is critical.

Flight crews are expected to maintain procedure centerlines depicted by lateral and vertical deviation indicators and/or flight guidance. Close adherence to track centerline is especially critical during curved legs (RF legs). Limits for lateral and vertical track are provided below:

- Lateral deviation for normal operations should be limited to $\pm$ one dot. Momentary lateral deviations during and immediately after turns, up to a maximum of $\pm$ two dots deviation are allowable.
- Vertical deviation for normal operations should be limited to $\pm\frac{1}{2}$ dot during the final approach segment (FAF to MAP). Momentary vertical deviations up to 75 feet above or 50 feet below glidepath are allowable.

NOTE:

Vertical deviation (VDEV) in feet can be observed on FMS NAV page 1/4.

Authorized RNP Minimums

The Q400 is authorized for RNP approach operations to the RNP 0.10 line of minima (see example below).

TERPS			
STRAIGHT-IN LANDING RWY TOR			
RNP 0.10 DA(H) 346' (823')		RNP 0.30 DA(H) 448' (425')	
ALS out		ALS out	
A			
B			
C	RVR 32 or 1/8	RVR 50 or 1	RVR 50 or 1
D			1 1/8

Altimeter Setting and Crosscheck

RNP approach operations require the use of barometric VNAV for glidepath guidance to minimums (DA). Since the accuracy of the glidepath provided by baro-VNAV is dependent on the accuracy of the barometric setting of each primary altimeter, it is essential the flight crew ensures the current altimeter setting is set no later than the FAF. After the current altimeter setting for the approach has been set:

- As the aircraft crosses over the FAF the PM shall conduct the instruments and altitude crosscheck.
- If the altitude crosscheck between the two primary altimeters exceeds 100 feet, a missed approach shall be executed unless visual reference to the runway environment has been established and the aircraft is in a position to allow the safe continuation to a landing.

Missed Approach Requirements

Unless the visual references required to continue to the intended runway have been acquired, a missed approach shall be initiated if:

- Lateral deviation exceeds ± 2 dots.

NOTE:

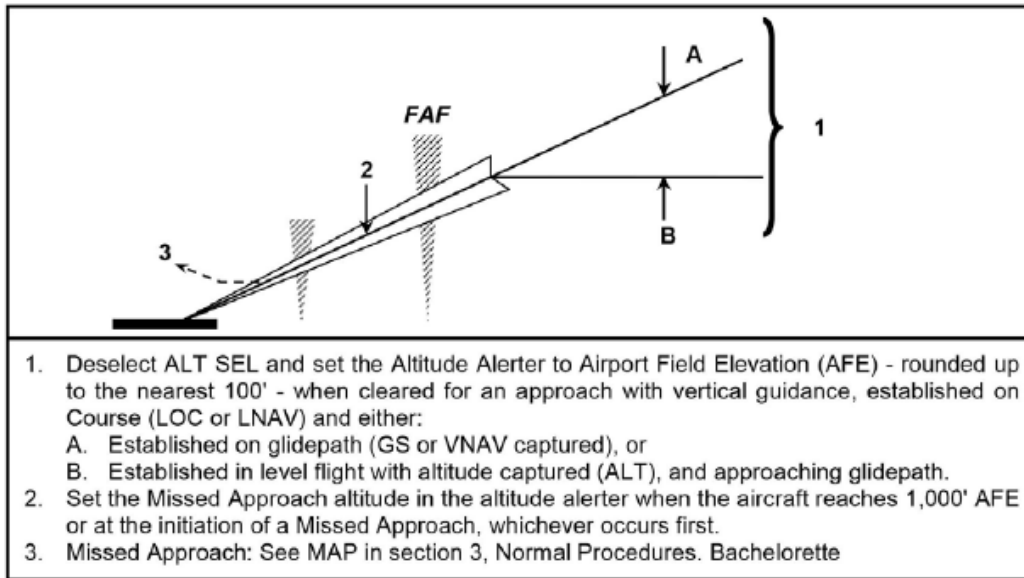
Momentary full scale deflection of the CDI needle associated with a waypoint crossing that includes a course change or a reduction in RNP does not require an immediate missed approach, provided the aircraft acquires the new course in an appropriate manner.

- Vertical deviation during the final approach segment (FAF to MAP) exceeds 75 feet above glidepath or 50 feet below glidepath.
- The altitude between the two primary altimeters exceeds 100 feet as the aircraft crosses the FAF.
- A missed approach is required if any of the following appear on the PF FMS or PFD and are not resolved by the FAF:
 - NAV flag
 - POS (position uncertain message)
 - GPS INTEG message
 - No RAIM @ FAF
 - No RAIM @ MAP
 - FMS is not in Approach Scaling
- Loss of Flight Director
- Loss of autopilot when using minimums less than RNP 0.30.

Company Approach Out-of Service NOTAMs

Prior to initiating an RNAV approach, a check of the applicable portions of the weather packet shall be conducted to ensure the approach procedure is not listed Out-of-Service via a Company NOTAM.

Altitude Alerter Approach With Vertical Guidance



Descending on a STAR

- When using VNAV and cleared to descend on a STAR, the altitude alerter may be set to the lowest VNAV altitude in the ATC clearance, provided:
 - The waypoint VNAV verification procedures have been accomplished (section 3, Normal Procedures), and
 - Established on the LNAV and either:
 - Established on the LNAV glidepath, or
 - Established in level flight (ALT captured) and approaching the VNAV glidepath.
- When not using VNAV, set the first altitude limit in the altitude alerter. Set each new altitude as it becomes effective until the altitude clearance limit is reached.

Examples:

Clearance:	Cross BRNDI at FL240, descend via the HRIZN ONE Arrival.
Procedure:	- VNAV descent (with VNAV verification and VNAV glidepath): - Set the altitude alerter to the clearance limit – in this case, the lowest altitude on the HRIZN ONE arrival. - VS descent: - Set FL240 in the altitude alerter. After crossing BRNDI, set each new altitude as it becomes effective down to the lowest altitude in the HRIZN ONE arrival.
Clearance:	"Cross BRNDI at or above 12 thousand, then descend and maintain ten thousand."
Procedure:	Set the altitude alerter to 12,000' since the clearance is to descend no lower than 12,000' until after crossing BRNDI intersection. The altitude alerter should be set to 10,000' as follows: - VNAV descent: - The altitude alerter should be set to 10,000' after verifying the altitude restriction at BRNDI will be met. - VS descent: - The altitude alerter should be set to 10,000' after passing BRNDI.
Clearance:	"Cross BRNDI at or below 12 thousand, descend and maintain ten thousand,"
Procedure:	Set the altitude alerter to 10,000' since this is the altitude you are cleared to and you are not required to stop the descent at any point. Evaluate the descent to ensure the aircraft will cross BRNDI at or below 12,000'.

NOTE:

Always advise ATC immediately if any crossing restriction will not be met.

Instrument Approach **With** Vertical Guidance (Glidepath)**NOTE:**

These procedures assume the FMS Verification procedures have been accomplished. (See General in section 3, Normal Procedures.)

- Setting alerter for a VNAV transition to an ILS.
 - When cleared for the approach, the alerter is set to the lowest charted VNAV altitude.
 - After changing the NAV SOURCE to the Localizer, the alerter is set to airport elevation as described below.

- Setting alerter to airport elevation (approaches with vertical guidance).
The altitude alerter is set to airport elevation rounded up to the nearest 100-foot increment when the following criteria are met:
 - Cleared for an approach with vertical guidance (ILS or VNAV)
 - Established on the Localizer or LNAV, and
 - Either:
 - Established on glidepath (GS or VNAV captured), or
 - Established in level flight (ALT captured) and approaching the glidepath.

NOTE:

- *The FMS VNAV function may not capture if the altitude alerter is not set to airport elevation prior to "Glidepath alive."*
- *If the alerter is set too late for the glidepath to capture, use VS, etc., to maneuver the aircraft to capture the glidepath.*

Deselect ALT SEL when setting field elevation in the alerter (if selected). This is to prevent the VNAV from uncoupling when the alerter is set to the missed approach altitude.

The altitude alerter chime at 1,000' AFE serves as a reminder to ensure final landing configuration and any applicable 1,000' autopilot limitations.

- Setting alerter to missed approach:
When the aircraft reaches 1,000' AFE or at the initiation of a missed approach (whichever occurs first), set the altitude alerter to the applicable missed approach altitude. Do not select the altitude alerter to the missed approach altitude while the aircraft is above 1,000' AFE unless executing a missed approach.
State "Missed Approach ____" when the missed approach altitude is set. (e.g., "Missed Approach 4,000.")

Instrument Approach Without Vertical Guidance (Circling Approaches)**NOTE:**

Unless specifically approved, approaches without vertical guidance shall not be used inside the FAF in IMC conditions.

- Setting alerter for a VNAV transition to the FAF.
 - If the FMS Verification procedures have been accomplished. (See Section 3.1), VNAV may be used until reaching the FAF,
 - When cleared for the approach, the alerter is set to the lowest charted VNAV altitude up to the FAF.
 - At the FAF, the alerter is set to airport elevation as described below.
- Setting alerter down to MDA:
 - When descending on an approach without vertical guidance:
 - The altitude alerter shall be used for intermediate step-down altitudes and MDA, each rounded up to the nearest 100-foot increment, with ALT SEL selected.
 - The altitude alerter shall be reset to each new step-down altitude when it becomes effective until the approach progresses down to the MDA.