Federal Aviation Administration

Memorandum

Date: JUN 06 2012

To: Chas. Frederic Anderson, Director, Aeronautical Products, AJV-3

From: Gary L. Powell, Acting Manager, Flight Technologies and Procedures Division, AFS-400

Subject: Low/High Temperature Limits For Barometric Vertical Navigation (Baro-VNAV) Based Approach Procedures

The purpose of this memorandum is to harmonize the calculation of low and high temperature limits for all Baro-VNAV based approach procedure designs.

Attachment 1 contains the standard criteria formulas for determination of Baro-VNAV high and low temperature limits, delta-ISA values, and a calculator. Use the calculator to determine the published low and high temperature limits for Lateral Navigation with Vertical Guidance (LNAV/VNAV) developed under Order 8260.54A, *The United States Standard for Area Navigation (RNAV)*, and approach procedures developed under Order 8260.52, *United States Standard For Required Navigation Performance (RNP) Approach Procedures With Special Aircraft And Aircrew Authorization Required (SAAAR)*. The calculator can also determine the maximum expected descent rate at the airport standard temperature and at the high temperature limit. Use the calculator's delta-ISA value (Celsius) for input into the RNP SAAAR Vertical Error Budget (VEB) calculations. Add the following statement to Form 8260-9 documentation, "Temperature limits, delta-ISA low, and descent values derived from AFS-400 calculator". Example:

BARO-VNAV NA BELOW -17C (1F) OR ABOVE 48C (116F)
DELTA ISA LOW -30.12
DESCENT RATE: STANDARD TEMP 974 HIGH TEMP 1126
TEMPERATURE LIMITS, DELTA ISA LOW, AND DESCENT VALUES DERIVED FROM AFS-400 CALCULATOR

The memorandum supersedes Order 8260.52, paragraph 3.2.1, Order 8260.54A, paragraphs 4.3.1 and 4.3.2., and AFS-400 Memorandum, dated September 24, 2010, Subject: Determining Average Cold Temperature (ACT) for Barometric Vertical Navigation (Baro-VNAV) Based Approach Procedures.

The criteria introduced in this memorandum will be incorporated in to Order 8260.PBN. If you have any questions, please contact Mr. Rick Dunham, Manager, Flight Procedure Standards Branch, AFS-420, at (405) 954-4164.

Cc: Joe McCarthy, Manager, AJV-14
Jeff Bruce, Airspace Design and Simulation, Jeppesen Sanderson, Inc.
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High & Low Temperature Limit Criteria

The criteria are the following formulas.

***Note**: high limit based on 1.13 × fastest published category's max glidepath angle, low limit based on a 2.5° effective glidepath angle*

input θ, LTP_{elev}, *TCH*, $airport_{elev}$, *C$*

where

θ = *designed glidepath angle in degrees*
LTP_{elev} = *LTP elevation in feet*
TCH = *Threshold crossing height in feet*
$airport_{elev}$ = *Airport elevation in feet above mean sea level*
C$ = *Fastest published category*

constants: r=20890537 mean earth radius in feet

- - - - -{ Determination of Max glidepath angles and indicated airspeeds }- - - - - -

if C$="A" then
V_{KIAS} = 90
α = 5.7
end if
if C$ = "B" then
V_{KIAS} = 120
α = 4.2
end if
if C$ = "C" then
V_{KIAS} = 140
α = 3.6
end if
if C$ = "D" then
V_{KIAS} = 165
α = 3.1
end if

- - - -{Determination of Descent Rates (DR) at high temp limit and ISA standard temperature }- - - - - -

(1) $MDR_{angle} = 1.13 \times \alpha \times \frac{\pi}{180}$

(2) $DR_{high\_temp} = \text{ceiling}\left[\sin\left(MDR_{angle}\right) \times \left(\frac{\left(V_{KIAS}\right) \times 171233 \times \sqrt{303 - 0.00198 \times \left(LTP_{elev} + 250\right)}}{\left(288 - 0.00198 \times \left(LTP_{elev} + 250\right)\right)^{2.628}} + 10\right) \times 101.26859\right]$

(3) $DR_{standard\_temp} = \text{ceiling}\left[\sin\left(\theta \times \frac{\pi}{180}\right) \times \left(\frac{\left(V_{KIAS}\right) \times 171233 \times \sqrt{303 - 0.00198 \times \left(LTP_{elev} + 250\right)}}{\left(288 - 0.00198 \times \left(LTP_{elev} + 250\right)\right)^{2.628}} + 10\right) \times 101.26859\right]$

- - - - - - - - - - - - - - - - -{ High Temperature Limit }- - - - - - - - - - - - - - - - -

{High temperature limit based on 1.13 times the max allowable glidepath angle for the fastest published aircraft category}

(4) $ISA_{airport} = 15 - 0.00198 \times airport_{elev}$

(5) $d_{DA\_ft} = \text{ceiling}\left[\frac{r \times \ln\left(\frac{r + LTP_{elev} + 250}{r + LTP_{elev} + TCH}\right)}{\tan\left(\theta \times \frac{\pi}{180}\right)}\right]$

(6) $\Delta DA_{MDR_{angle}} = e^{\frac{d_{DA\_ft}}{r} \times \tan\left(MDR_{angle}\right)} \times \left(r + LTP_{elev} + TCH\right) - \left(r + LTP_{elev} + 250\right)$

(7) $\Delta ISA_{high} = \frac{\Delta DA_{MDR_{angle}} \times \left(288 - 0.5 \times 0.00198 \times \left(LTP_{elev} + 250\right)\right)}{250 - \Delta DA_{alt}}$

(8) $temp_{high°C} = ISA_{airport} + \Delta ISA_{high}$

$temp_{high°F} = temp_{high°C} \times 1.8 + 32$

(9) $case\ temp_{high°C} \geq 54 \quad NA_{above°C} = 54$

$NA_{above°F} = 130$

$case\ temp_{high°C} < 54 \quad NA_{above°C} = \text{floor}\left[temp_{high°C}\right]$

$NA_{above°F} = \text{floor}\left[temp_{high°F}\right]$

- - - - - - - { Calculation of Low Temperature Limit } - - - - - - -

{Low temperature based on effective glidepath angle of 2.5 degrees}

(10) $\Delta DA_{alt\_2.5} = \left(r + LTP_{elev} + TCH\right) \times e^{\frac{d_{DA\_ft}}{r} \times \tan\left(2.5 \times \frac{\pi}{180}\right)} - \left(r + LTP_{elev} + 250\right)$

(11) $\Delta ISA_{2.5} = \frac{\Delta DA_{alt\_2.5} \times \left(288 - 0.5 \times 0.00198 \times \left(LTP_{elev} + 250\right)\right)}{250 - \Delta DA_{alt\_2.5}}$

(12) $NA_{below}°C = \text{ceiling}\left[ISA_{airport} + \Delta ISA_{2.5}\right]$

$NA_{below}°F = \text{ceiling}\left[NA_{below}°C \times 1.8 + 32\right]$