Memorandum

U.S. Department
of Transportation
**Federal Aviation
Administration**

Subject: **ACTION:** Automated Precipitous Terrain Adjustments   Date: JUN 1 8 2004

From: Manager, Flight Technologies and Procedures Division,   Reply to
AFS-400   Attn. of:

To: Program Director, Aviation Systems Standards, AVN-1

We are working toward resolution of an Aeronautical Charting Forum, Instrument Procedures Group (ACF-IPG) agenda item and National Transportation Safety Board (NTSB) Safety Recommendations A-96-131 and A-96-132, regarding precipitous terrain adjustments for instrument approach procedures. The precipitous terrain automated evaluation program is part of Change 20 to Order 8260.3B, *U.S. Standard for Terminal Instrument Procedures (TERPS)*, in response to the National Transportation Safety Board's recommendations regarding this issue. Since work began on this project, a revised version of the Instrument Approach Procedures Automation (IAPA) system software that implements the precipitous terrain evaluation routines developed and provided by AFS-400 was accomplished and is awaiting implementation. Our original intent was to implement this program concurrent with TERPS, Change 20; however, recent changes to Title 14 of the Code of Federal Regulations (14 CFR), Part 97.20 is delaying processing the change.

During the April 26-27, 2004 meeting of the ACF-IPG, industry representatives questioned why the FAA does not begin using the revised IAPA programming immediately. The ACF-IPG believes the automated program will ensure a uniform application of precipitous terrain adjustments for civil instrument approach procedures and it should be implemented without delay.

We agree that the safety benefit provided by implementation should not be delayed. Please take action to implement the precipitous terrain IAPA programming under the attached guidelines as soon as possible.

If you have any questions, please contact AFS-420 at 405-954-4164.

John W. McGraw

Attachment

Precipitous Terrain Equations, Parameters, Interests, Weights, and Adjustment Values

A digital terrain database (100 meters or 3 arcsecond separation density or better) must be used for the determination of precipitous terrain. The precipitous terrain area will contain the prescribed segment (both primary and secondary, if applicable) and a 2 NM buffer surrounding that segment. For segments that are comprised of multiple legs, each leg should be evaluated separately. The digital terrain data within the defined area will be analyzed electronically to determine the values of five specific parameters ($g(1)$ through $g(5)$), which will be transformed into interest values ($I(1)$ through $I(5)$), weighted ($W(1)$ through $W(5)$), and then combined to determine the base precipitous adjustment.

Step 1. The equations, minimum and maximum thresholds, and weight values for each parameter are:

Average elevation

$$g(1) = \frac{\sum h(x,y)}{n}$$

$min(1) = 600$ meters

$max(1) = 3000$ meters

$W(1) = 0.05$

98th percentile - 2nd percentile height differential

$$g(2) = h_{98percentile} - h_{2percentile}$$

$min(2) = 250$ meters

$max(2) = 2500$ meters

$W(2) = 0.30$

Slope gradient

$$g(3) = \sqrt{\left(\frac{D_a}{D}\right)^2 + \left(\frac{D_b}{D}\right)^2}$$

$min(3) = 0.015$

$max(3) = 0.060$

$W(3) = 0.10$

Standard deviation from plane of best fit

$$g(4) = \sqrt{\dfrac{\sum \left[h(x,y) - \left(\dfrac{D_a \times x}{D} + \dfrac{D_b \times y}{D} + \dfrac{D_c}{D}\right)\right]^2}{n}}$$

$min(4) = 40$ meters

$max(4) = 200$ meters

$W(4) = 0.35$

98th percentile max - min height differential within **0.50 NM of each terrain posting**

$g(5) = (h_{max} - h_{min})_{98percentile}$

$min(5) = 100$ meters

$max(5) = 1000$ meters

$W(5) = 0.20$

Step 2. The interest values are based on the parameter thresholds and are found via this piecewise function:

$g(i) < min(i)$:

$I(i) = 0$

$min(i) \leq g(i) \leq max(i)$:

$$I(i) = \dfrac{g(i) - min(i)}{max(i) - min(i)}$$

$g(i) > max(i)$:

$I(i) = 1$

Step 3. The combined interest (CI) is computed as follows:

$CI = W(1) \times I(1) + W(2) \times I(2) + W(3) \times I(3) + W(4) \times I(4) + W(5) \times I(5)$

Step 4. The base precipitous adjustment (BA) is also a piecewise function with a minimum threshold of 0.20 and a maximum of 0.60.

$CI < 0.20$:

$BA = 0$

$0.20 \leq CI \leq 0.60$:

$BA = 500 \times CI - 50$

$CI > 0.60$:

$BA = 250$

Step 5. Finally, BA is applied and rounded varyingly depending on the evaluated segment to derive the actual adjustment (A).[1]

Rounded to the next higher 1 foot increment:

Precision and APV finals[2]

$$A = \mathbf{0.10} \times HAT$$

Rounded to the next higher 10 foot increment:

Non precision finals

$A = BA$

Intermediate

$A = 1.25 \times BA$

Initial, holding, & missed approach level surface

$A = 1.5 \times BA$

Notes:

1. Precipitous terrain evaluation is not required for departures and the sloping portion of missed approach. Where precipitous terrain evaluation is required, refer to additional guidance provided by criteria.
2. When $BA > 0$, use the HAT output based on final and missed approach assessment, excluding remote altimeter adjustments.

Explanation of variables:

$h(x, y) = $ height (meters) of the selected terrain posting

$x = $ x coordinate of the selected terrain posting

y = y coordinate of the selected terrain posting

n = number of terrain postings in the area

$h_{98percentile}$ = height (meters) of the 98th percentile terrain posting

$h_{2percentile}$ = height (meters) of the 2nd percentile terrain posting

h_{max} = height (meters) of the highest terrain posting within 0.50 NM of the selected post

h_{min} = height (meters) of the lowest terrain posting within 0.50 NM of the selected post

$$D = \begin{vmatrix} \sum x^2 & \sum x \times y & \sum x \\ \sum x \times y & \sum y^2 & \sum y \\ \sum x & \sum y & n \end{vmatrix}$$

$$D_a = \begin{vmatrix} \sum x \times h(x,y) & \sum x \times y & \sum x \\ \sum y \times h(x,y) & \sum y^2 & \sum y \\ \sum h(x,y) & \sum y & n \end{vmatrix}$$

$$D_b = \begin{vmatrix} \sum x^2 & \sum x \times h(x,y) & \sum x \\ \sum x \times y & \sum y \times h(x,y) & \sum y \\ \sum x & \sum h(x,y) & n \end{vmatrix}$$

$$D_c = \begin{vmatrix} \sum x^2 & \sum x \times y & \sum x \times h(x,y) \\ \sum x \times y & \sum y^2 & \sum y \times h(x,y) \\ \sum x & \sum y & \sum h(x,y) \end{vmatrix}$$

To compute the determinant, use the following:

$$Matrix = \begin{vmatrix} A & B & C \\ D & E & F \\ G & H & I \end{vmatrix}$$

$$D = A \times E \times I + B \times F \times G + C \times D \times H - A \times F \times H - B \times D \times I - C \times E \times G$$

Edited: October 2014 (reformatted and bolded changes). To be incorporated into 8260.3C.