Subject: Differential GPS Demonstration Approach at KTEB

Keywords: GPS, DGPS, Differential GPS, TEB, KTEB, Terminal Instrument Procedures, TERPS, Special Category I, SCAT I

December 29, 1996

Bluecoaters:

Thanks to Michael Moore, Steve Bergner and others, this PDF file is now available on the Bluecoat Reports site, and contains an *uncertified* Differential GPS (DGPS) instrument approach procedure that is currently being tested at the Teterboro, New Jersey, airport (KTEB). This primarily corporate aviation facility is located directly across the Hudson river (west) from the island of Manhattan (New York), and is only a few miles north of the Newark International Airport (KEWR). KTEB lies directly under the approach paths for the south runways at KEWR.

In IFR weather, when surface winds dictate that instrument approaches be made to the south, KTEB traffic has limited options: Make non-precision VOR/GPS circling or straight-in approaches to runways 19 or 24, or else make *downwind* ILS approaches to runways 1 or 6—with the latter being in direct opposition to the southerly flow of traffic landing at KEWR. Development of a straight-in Runway 19 approach—precision or otherwise—has until now been precluded by obstructions to the north of the airport.

This PDF package describes a DGPS test procedure for KTEB Runway 19 that, due to relatively recent changes in obstruction clearance criteria, should eventually be certified for non-public “Special Category I” (SCAT I) precision approach minima. While these documents do get somewhat into the “nuts and bolts” of IAP design, they nonetheless should prove interesting to any number of Bluecoat readers.

Your comments and suggestions are welcome.

Best regards,

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Michael Moore <NTTH19A@prodigy.com> writes:

The enclosed DGPS Rwy 19 chart for Teterboro, NJ, and the accompanying Technical Data Sheet, are the result of a lot of work over the past few years; not only by the Federal Aviation Administration, but by First Aviation Services located at the Teterboro Airport and by Mike Moore, who has been a predominant participant in the development of the obstacle clearance criteria as well as the enclosed chart and Technical Data Sheet.

Due to the presence of two radio towers northeast of the Teterboro airport, it has been impossible to install a straight-in precision ILS system or even a reasonably offset LDA nonprecision system. The present Terminal Instrument Procedures (TERPS) criteria for ILS are now considered to be unnecessarily broad. Those ILS criteria were first published in 1968 when the Boeing 747 had yet to be introduced into public service.

With the introduction of Microwave Landing System (MLS) precision approach procedures, new obstacle clearance criteria were developed and tested. Although MLS is now being pushed aside in favor of Global Positioning System (GPS), these criteria are the basis for the construction of Special Category I (SCAT I) Differential Global Positioning System (DGPS) precision final approach procedures. The obstacle clearance surfaces are now shaped somewhat like a football, with three ascending surfaces on each side of the course centerline. The radio towers, which were a problem in the past, are well outside of the obstacle clearance surfaces and are thus removed from consideration.

Using the MLS approach criteria and a *certified* Differential ground station (the current TEB demonstration system is *not* certified), the FAA eventually will approve the use of such "Special" DGPS procedures for *non-public* IFR use. “Non-public” means that anyone wishing to use a certified TEB DGPS Rwy 19 procedure and the certified ground and airborne system will require specific written approval, either from their FAA FSDO (under FAR Part 91) or their Principal Operations Inspector (under FAR Parts 121 or 135).

Public use DGPS procedures criteria, which will apply to *all* precision approach procedures, are presently being developed by the FAA and will eventually be a part of the TERPS document. The final approach obstacle clearance surfaces are expected to remain the same (or very much the same) as the SCAT I criteria now in use for this demonstration.

For the DGPS Rwy 19 demonstration at Teterboro, several organizations and individuals have contributed. Joseph Ritorto of First Aviation Services at Teterboro has generated this entire project and even supplied his own Bonanza A-36 (N5831R) for the demonstration. The National Business Aircraft Association (NBAA) is sponsoring the project and has contributed over $2000

for the GPS survey. The FAA loaned the Differential Station to First Aviation. Dick Weaver of the FAA's New York Flight Procedures Office (NYFPO) approved Mike Moore's procedure for the project. Joe Ritorto of First Aviation bought a Trimble 2000 and the receiver as well as an Argus moving-map display. Clark Gordon, Regional Avionics Representative for Duncan Aviation, set up the Differential station and DGPS software and installed the avionics in the Bonanza. Peter Wendt conducted the first test flights and is still active in finalizing the tests.

Tom Benenson of *Flying* Magazine is expected to participate in the demonstration and write an article for the magazine. In addition, there is talk of including the planned Newark, NJ, Differential Station in the Teterboro demonstration to test whether a station not located on or near the primary airport can be used successfully and with the same accuracy.

Best regards, Mike Moore

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December 6, 1996
First Aviation Services

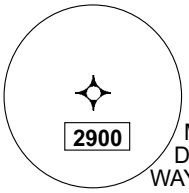
TETERBORO (TEB)

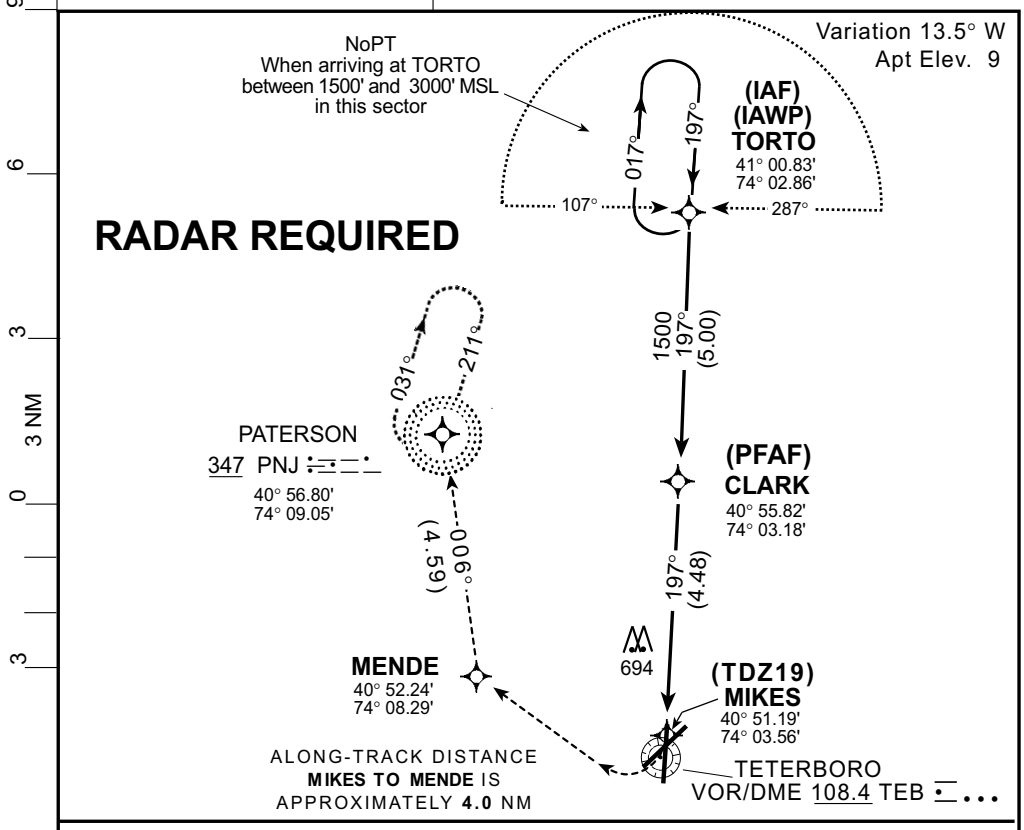
TETERBOR0, NEW JERSEY

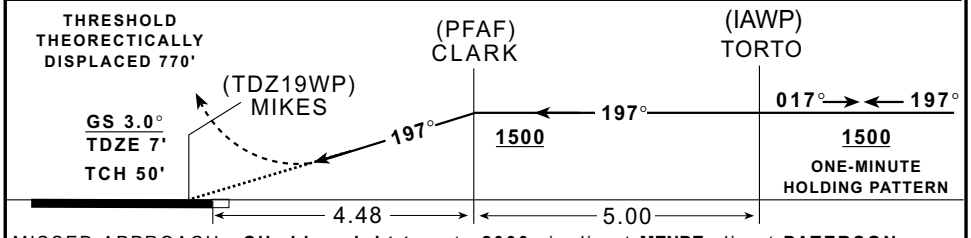
DGPS RWY 19

LOCAL DGPS 136.3 MHZ

ATIS	**132.05 114.2**
NEW YORK APPROACH	**127.6**
TETERBORO TOWER	**119.6**
GROUND	**121.9**
CLNC DEL	**128.05**







MISSED APPROACH: **Climbing right turn** to **2000** via direct **MENDE**, direct **PATERSON WAYPOINT/NDB** and **hold**. Cross **MENDE at 1000 or above.**

STRAIGHT-IN-LANDING RWY **19**

A	*DA(H)* **207'** *(200')*
B	**VIS 3/4**
C	
D	

Maximum Knots	CIRCLE-TO-LAND MDA *(H)*
90	**760'** *(751)* - **1**
120	**1000'** *(991)* - **1 1/2**
140	**1000'** *(991)* - **3**
165	

Ground speed - Knots		70	90	100	120	140	160
Glide Path	3.00°	377	485	539	647	755	862

Circling not authorized CATS B, C and D
Northwest of runway 6 and 19

CHANGE: RELOCATED MIKES WP TO TDZWP AT GPI
RENAMED PFAF

PROCEDURE DESIGN AND DESKTOP PUBLISHING BY MIKE MOORE

FOR VFR DEMONSTRATION ONLY

TECHNICAL DATA SHEET
FOR DGPS PRECISION APPROACH
VFR DEMONSTRATION ONLY
TETERBORO, NJ RUNWAY 19
Revised December 6, 1996

The data necessary to publish the approach chart and to enter into the airborne data base are listed separately. Because Johnson Controls plans to displace the existing threshold in the future to 770', this DGPS demonstration procedure is predicated on that displacement. The following data applies:

APPROACH CHART DATA

1. Threshold, RWY 19 theoretically displaced 770' (as planned).

2. Glide Path 3.00°; GPI 954' (from displaced threshold); TCH 50'

3. Elevation of the displaced threshold 7' MSL.

4. Magnetic Variation 13.5W (increased .5 since 1990; reference NOS Airport Diagram, 02 Feb. 1995).

5. The obstacle clearance criteria found in accordance MLS Order 8260.36A, dated 1/19/96, has been used for this procedure. The intent of the FAA is to have one common precision criteria for ILS, MLS, and DGPS. **The MLS criteria found in paragraph 20 of the MLS order and associated Figures (copies attached) do not allow adjustment of the DH when there are obstacles that penetrate the "W" surface (center channel).** A waiver to adjust the DH can be processed through AFS-420 for IFR DGPS procedures where the 34:1 is penetrated but the 20:1 is not. The equivalent level of safety should be "no penetration of the 20:1". **This DGPS procedure for Rwy 19, will be conducted in VFR conditions only until the ground station and airborne system are certified by the FAA and the trees are either removed or a waiver is approved.**

6. The **controlling obstacle** in the final approach is a **68-foot tree** across the street from the airport near the centerline of the final approach track. The **694' ABC radio towers** located to the west of the final approach course are removed from consideration when applying the new MLS obstacle clearance surfaces (See the attached diagram of the obstacle clearance area). **No obstacles penetrate the 20:1 surface**.

7. The geographic coordinates of the **existing threshold,** as listed in NOS OC 890 (published February 1990), were converted from NAD-27 to NAD-83. The **NAD-83** values are: **40° 51' 28.3113" N and 074° 03' 32.248" W**. The coordinates of the **theoretical threshold** (displaced 770') was determined using the NOS COMPSYS

Program Version 5.4 based on the NAD-83 coordinates of the existing threshold, the true bearing of the runway, and a distance of 770' (0.126726 NM). The **NAD-83** coordinates of the **theoretical threshold** are: **40° 51' 20.715" N and 074° 03' 32.806"W** . According to Mr. David R. Doyle, Senior Geodesist at the National Geodetic Survey, Silver Spring, Maryland, the NAD-83 coordinates are equivalent to WGS-84 in the horizontal component.

8. The straight final approach waypoints were established in accordance with the draft DGPS SCAT-1 FAA Order (attached) which requires that the waypoints be established using the **reciprocal of the inbound true bearing (± 180°) of the runway** (in this case 183.190556 - 180° = 003.190556°). Then, use the inbound true bearing for the inbound course. In this case the true inbound straight final approach course is 183.190556°.

9. As stated above, the **true final approach runway bearing** from the NOS OC 890 chart is **183.190556**°. When the current **variation of 13.5**° is added to the true inbound bearing, the **inbound magnetic bearing** becomes **196.690556**°. This is rounded to **197° for publication on the approach chart.**

10. In accordance with the DGPS SCAT-1 draft order, the threshold-crossing waypoint (TCWP) and the precision final approach fix waypoint (PFAF) must be 3D waypoints in the airborne data base. In other words, the data base must include the elevation of these waypoints above the WGS-84 ellipsoid. All other waypoint elevations are stated in MSL (2D only) in the data base. **For this demonstration, the TCWP has been eliminated and MIKES moved to the glide path's Ground Point of Intercept (GPI). It has been named the Touch Down Zone Waypoint (TDZ19WP)The published approach chart shows only MSL (2D) values for the pilot to read.**

11. **The PFAF (glide path intercept point) should have a charted MSL elevation that includes earth curvature based on the distance from the glide path's Ground Point of Intercept (GPI).** In this case, I have designed the procedure so that the published glide path intercept altitude of 1500' MSL at 4.48 nm from the theoretically displaced threshold includes earth curvature; that is, the elevation of the intercept point above the Approach Surface Baseline (ASB) + 50' TCH + 17.72' of earth curvature + the 7' elevation of the ASB = 1500.81'.

12. The frequency of the Local DGPS Segment (Station) is 136.3 MHZ and is published on the approach chart under the procedure title.

AIRBORNE DATA BASE ENTRIES

1. Threshold, RWY 19 theoretically displace 770' (as planned).

2. Glide Path 3.00°; GPI 954' (from displaced threshold); TCH 50'

3. Final approach true inbound bearing is 183.190556°

4. WGS-84 Elevation of the 770' displaced threshold is:
   -100.062' (Below the Ellipsoid)

5. **WGS-84 Elevation of the Threshold Touchdown Zone Waypoint (TDZ19WP)is: -100.062' (Below the Ellipsoid)**

6. WGS-84 Elevation of the PFAF (FAWP) is:
   +1396.252' (Above the Ellipsoid**)** This is based on the survey mentioned below.

7. Magnetic Variation slaved at 13.5° W (as of 1995 / increased .5 since 1990; reference NOS Airport Diagram, 02 Feb. 1995).

8. **NAD-83 geographic coordinates of the Touchdown Zone Waypoint (TDZ19WP): 40° 51' 11.303" N / 074° 03' 33.497" W**

9. NAD-83 geographic coordinates of the Final Approach Waypoint (FAWP and glide path intercept point): 40° 55' 49.262" N / 074° 03' 13.061" W

10. NAD-83 geographic coordinates of TORTO, the Initial Approach Waypoint (IAWP), are:
    41° 00' 48.975" N / 074° 02' 50.972" W

11. NAD-83 geographic coordinates of MENDE in the missed approach segment are:
    40° 52' 14.358" N / 074° 08' 16.745" W

12. NAD-83 geographic coordinates of PATERSON (PNJ) NDB/Waypoint as listed in the NOS DACS file are: 40° 56' 47.5" N / 074° 09' 03.1" W

13. The frequency of the Local DGPS segment (station) is 136.3 MHZ.

14. The NAD-83 geographic coordinates and the WGS-84 elevation above the ellipsoid for the Local DGPS Segment (Station) are:

    40° 51' 30.75295"N / 074° 03' 40.19971"W ; -66.522' (Below the Ellipsoid**)**

The WGS-84 elevations shown above were supplied via a satellite survey by the Atlantis Aerial Survey Co., Inc. for First Aviation Services of Teterboro Airport. These must be entered into the airborne data base before the procedure can be used in the demonstration project. The aircraft must fly the 3.0° glide path generated in the airborne system using the 3 dimensional PFAF and TDZ19WP fixes.