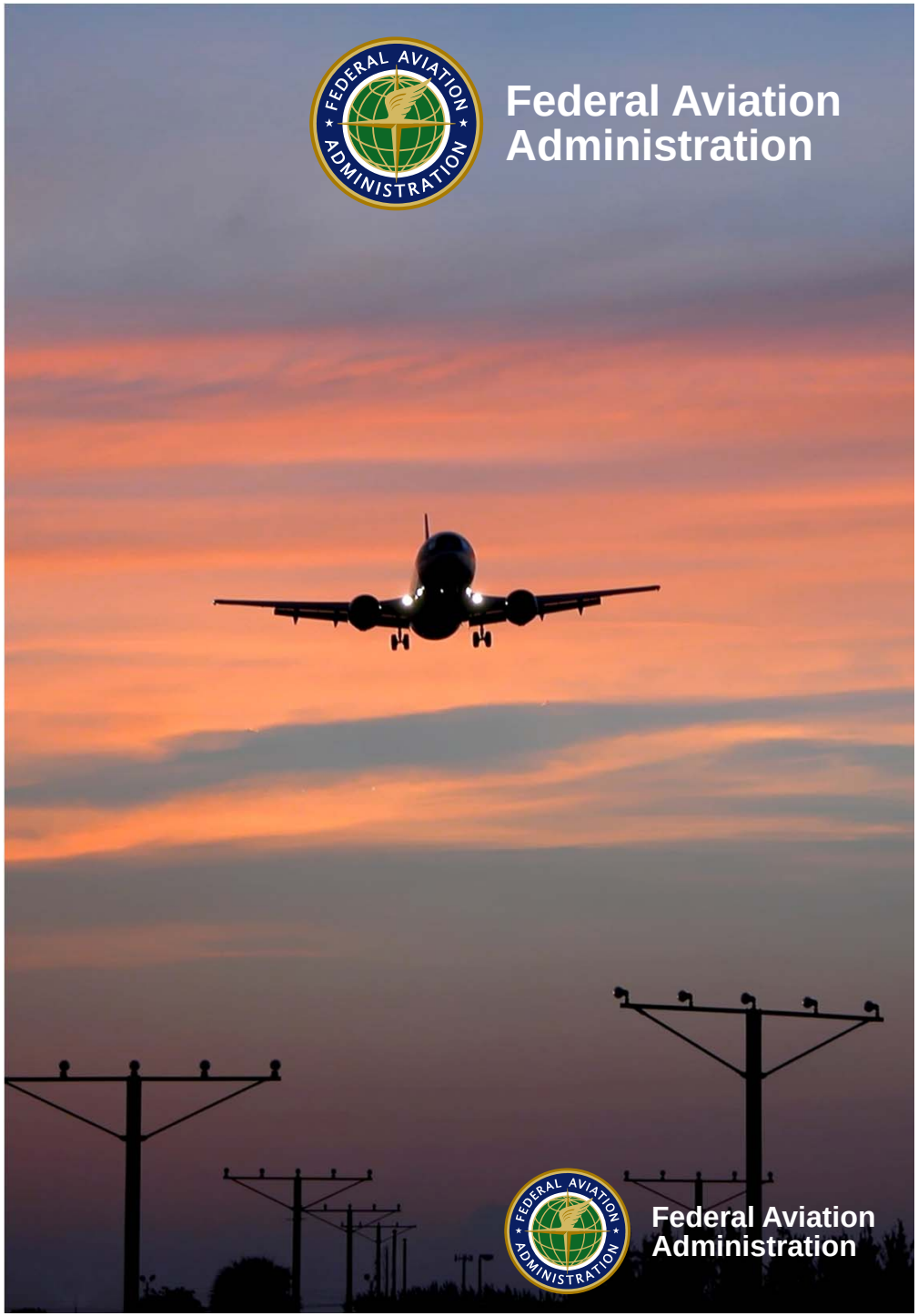
Overview of GNSS Flight Inspection

Presented to: ICAO Workshop on PBN and GNSS Precision Approach Operations

By: Bob Stuckert

Date: 17 August 2016



Why flight inspect?

- **Commissioning Inspection**

  Ensure required equipment and procedure are safe initially
- **Periodic Inspection**

  Ensure nothing has changed

Flight Inspection Objectives

- **Signal provides correct guidance**
- **Obstacle Clearance**

  VDA, if provided, clears obstructions
- **Communications with ATC**
- **Procedure delivers aircraft to correct position for landing or autoland**
- **Lighting and marking is correct**
  - VGSI is coincident with glide path

GNSS Flight Inspection

- **Instead of validating the signal in space, we are validating the data used in the procedure design**
- **Valid data depends on accurate survey**
- **FAA survey specifications are contained in AC 150/5300-18B Change 1, 24 Feb 2014**
- **NGS website explains geodetic terms:**

  https://www.ngs.noaa.gov/

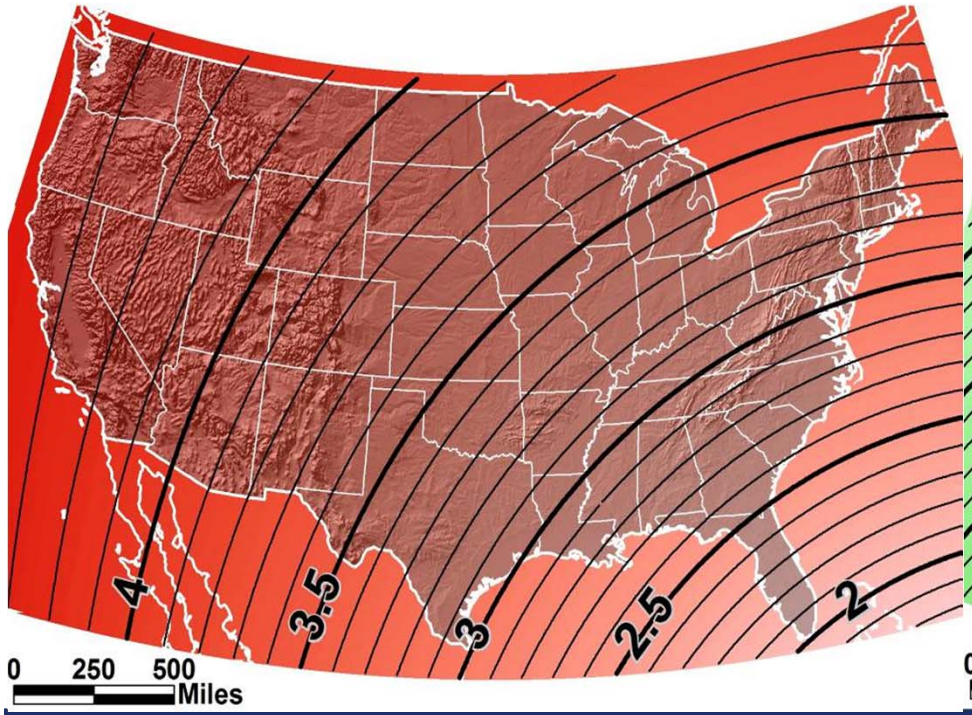
Is Datum Important?

- For unaugmented GPS (i.e. LNAV approach procedures) and SBAS, the datum must closely align with WGS-84
- For GBAS, it is not as important because the procedure is uplinked on the VHF data broadcast
- The US uses NAD83 horizontal and NAVD88 vertical datum
  - This allows earth connected survey (i.e. survey in relation to brass survey monuments located throughout the country)
  - The datum was designed to provide waypoint coordinates compatible with WGS-84

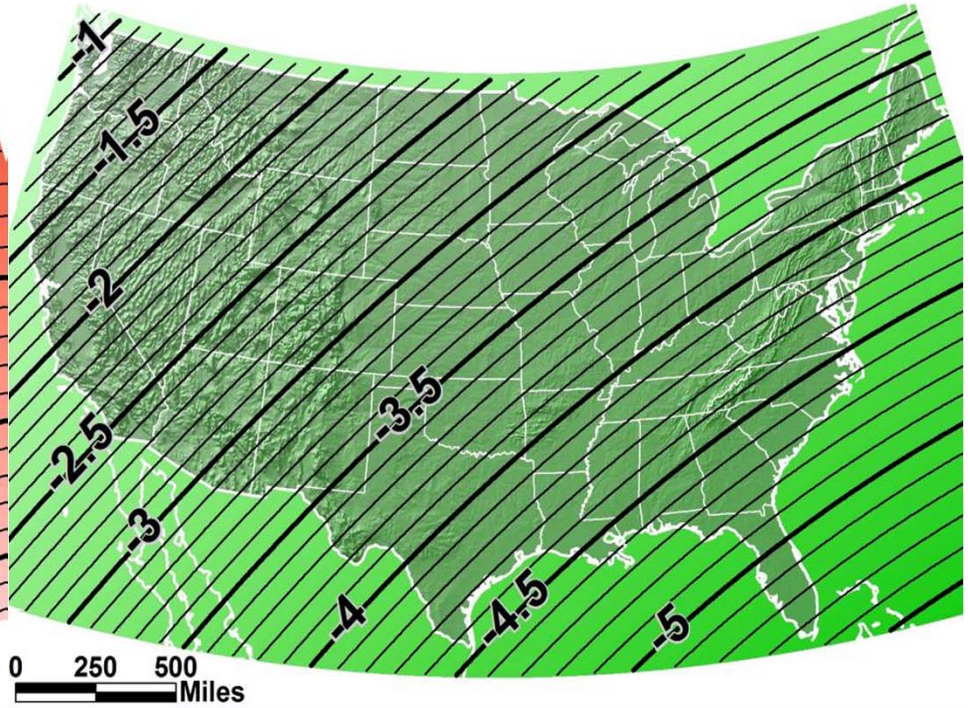
NAD83/NAVD88

Differences between NAD83/NAVD88 and WGS-84 result in the following errors:

Horizontal



Vertical



Unavoidable Errors

- **These errors must be considered in the error budget by the developers of PANS-OPS and TERPS procedure design criteria**
- **Flight inspection tolerances must tolerate them**
- **This is why the US tolerance for SBAS threshold crossing height (TCH) is +12 and -10 ft**

Coding Preflight Validation (CPV)

- **The paper forms legally define the flight procedure**
- **The database coding must match the paper forms**
- **CPV as a quality control measure continues to be needed**

US DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

RNAV - STANDARD INSTRUMENT APPROACH PROCEDURE TITLE 14 CFR PART 97.33

Bearings, headings, courses, and radials are magnetic. Elevations and altitudes are in feet, MSL, except HATh, HAA, TCH, and RA. Altitudes are minimum altitudes unless otherwise indicated. Ceilings are in feet above airport elevation. Distances are in nautical miles unless otherwise indicated, except visibilities which are in statute miles or in feet RVR.

TERMINAL ROUTES

FROM	TO	COURSE AND DISTANCE	ALTITUDE
IFI VORTAC	FILUM (FB)	114.87 / 22.45	5000
DAWKS	BEERY (FB)	078.03 / 14.94	5000
BEERY (IAF)	ROHAA (FB)	122.18 / 5.00	4000
FILUM (IAF)	ROHAA (FB)	174.96 / 3.50	4000
ROHAA (IF)	IVEYI (FB)	174.96 / 3.98	3000
IVEYI (FAF)	COTOX/1.50 NM TO RW17R (FB)	174.96 / 3.72	
(SEE FORM 8260-10)			

MISSED APPROACH

LPV: DA
LNAV/VNAV: DA
LNAV: RW17R

CLIMB TO 2000 THEN CLIMBING RIGHT TURN TO 3000 DIRECT JESKE AND HOLD.

ADDITIONAL FLIGHT DATA:
HOLD SW, RT, 036.15 INBOUND.
CHART FAS OBST: 1399 TREE 352449N/0973608W
CHART: 1577 TOWER 352953N/0973710W
CHART: ASR.
DISTANCE TO THLD FROM 200 HATH: 0.46 NM.
CHART VDP AT 1.00 NM TO RW17R*
*LNAV ONLY.
WAAS CHANNEL # 50102
REFERENCE PATH ID: W17A
CHART CIRCLING ICON.
CHART ARRIVAL HOLDING AT FILUM: HOLD N, RT, 174.96 INBOUND, 5000.
LTP HAE: 364 M

1. PT SIDE OF COURSE OUTBOUND FT WITHIN MILES OF (IAF)
2. PROFILE STARTS AT ROHAA
3. FAC: 174.96 FAF: IVEYI DIST FAF TO MAP: 5.22 THLD: 5.22
4. MIN. ALT: ROHAA 4000, IVEYI 3000, COTOX/1.50 NM TO RW17R 1800*
5. DIST TO THLD FROM OM: MM: IM: 150 HAT: 100 HAT: GS ANT:
6. MIN GS INCPT: 3000 GS ALT AT: IVEYI 3000 OM: MM: IM:
7. GS ANGLE: 3.00 TCH: 55.0 34:1 IS CLEAR
8. MSA FROM: RW17R 3800

MAG VAR: 5E EPOCH YEAR: 2010

MINIMUMS

TAKEOFF: SEE FAA FORM 8260-15A FOR THIS AIRPORT ALTERNATE: N A STANDARD @

CATEGORY =====>	A			B			C			D			E		
	DH/MDA	VIS	HATh/HAA	DH/MDA	VIS	HATh/HAA	DH/MDA	VIS	HATh/HAA	DH/MDA	VIS	HATh/HAA	DH/MDA	VIS	HATh/HAA
LPV DA	1482	2400	200	1482	2400	200	1482	2400	200	1482	2400	200	1482	2400	200
LNAV/VNAV DA	1598	2600	316	1598	2600	316	1598	2600	316	1598	2600	316	1598	2600	316
LNAV MDA	1660	2400	378	1660	2400	378	1660	3500	378	1660	3500	378	1660	3500	378
CIRCLING	1740	1	445	1760	1	465	1960	1 3/4	665	2000	2 1/4	705	2240	3	945

NOTES:
CHART NOTE: FOR UNCOMPENSATED BARO-VNAV SYSTEMS, LNAV/VNAV NA BELOW -12C (11F) OR ABOVE 54C (130F).
@ CAT D 800-2 1/4, CAT E 1000-3
CHART NOTE: DME/DME RNP-0.3 NA.
CHART PLANVIEW NOTE: PROCEDURE NA FOR ARRIVALS AT IFI VORTAC ON V140 SOUTHWEST BOUND.
(CONTINUED ON PAGE 2)

CITY AND STATE	ELEVATION: 1295 THRE: 1282 AIRPORT NAME:	FACILITY IDENTIFIER:	PROCEDURE NO./AMDT NO./EFFECTIVE DATE:	SUP:
OKLAHOMA CITY, OK	WILL ROGERS WORLD	RNAV	RNAV (GPS) Y RWY 17R, AMDT 4A, 06/23/2016	AMDT: 4
				DATED 07/24/2014

FAA FORM 8260 - 3 / April 2006 (computer generated)

U.S. DEPARTMENT OF TRANSPORTATION - FEDERAL AVIATION ADMINISTRATION

STANDARD INSTRUMENT APPROACH PROCEDURE
FLIGHT STANDARDS SERVICE - FAR PART 97.33

Bearings, headings, courses, and radials are magnetic. Elevations and altitudes are in feet, MSL, except HATh , HAA, TCH, and RA. Altitudes are minimum altitudes unless otherwise indicated. Ceilings are in feet above aiport elevation. Distances are in nautical miles unless otherwise indicated, except visibilities which are in statute miles or in feet RVR.

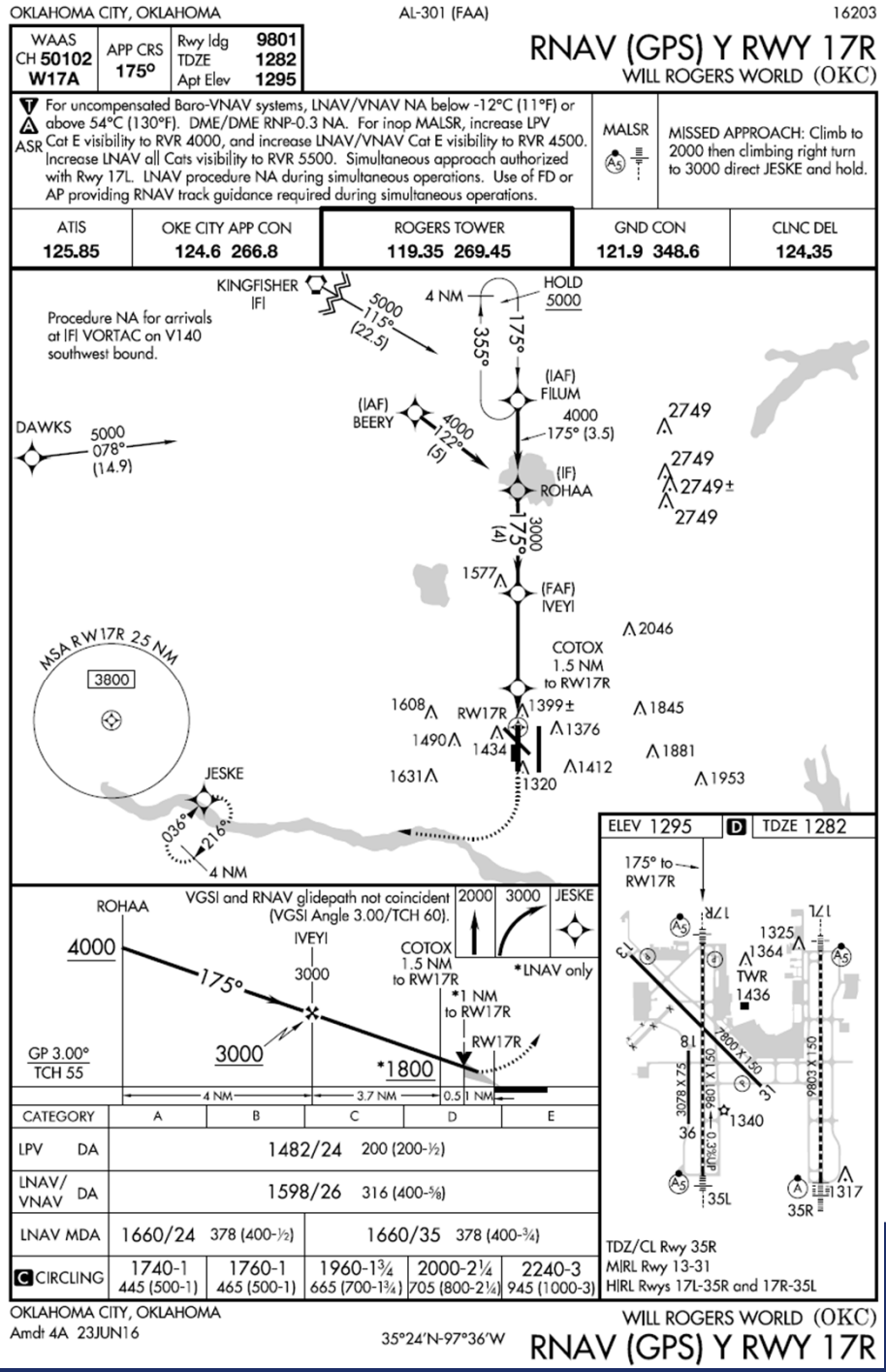
ARINC PACKET - 424-18 - RNAV (GPS)

```
                1         2         3         4         5         6         7         8         9         0         1         2         3
NAVAID  12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
        ----------------------------------------------------------------------------------------------------------------------------
        SUSAD        IFI    K4011470VTHW N35481896W098001410    N35481896W098001410E0090011122     NARKINGFISHER

                1         2         3         4         5         6         7         8         9         0         1         2         3
WP      12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
        ----------------------------------------------------------------------------------------------------------------------------
        SUSAEAENRT   DAWKS K40    W     N35344827W097592521                    E0041     NAR           DAWKS
        SUSAP KOKCK4CBEERY K40    W     N35363580W097411383                    E0040     NAR           BEERY
        SUSAP KOKCK4CCOTOX K40    C     N35255156W097362068                    E0039     NAR           COTOX
        SUSAP KOKCK4CFILUM K40    C     N35370459W097362126                    E0039     NAR           FILUM
        SUSAP KOKCK4CIVEYI K40    C     N35293525W097362087                    E0039     NAR           IVEYI
        SUSAP KOKCK4CJESKE K40    C     N35213136W097511235                    E0041     NAR           JESKE
        SUSAP KOKCK4CROHAA K40    C     N35333427W097362108                    E0039     NAR           ROHAA

                1         2         3         4         5         6         7         8         9         0         1         2         3
AIRPORT 12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
        ----------------------------------------------------------------------------------------------------------------------------
        SUSAP KOKCK4AOKC     0     030YHN35233507W097360274E005001295         1800018000C    MNAR    WILL ROGERS WORLD

                1         2         3         4         5         6         7         8         9         0         1         2         3
SEGMENT 12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
        ----------------------------------------------------------------------------------------------------------------------------
        SUSAP KOKCK4FR17RY ADAWKS 010DAWKSK4EA0E       IF                                          18000                A JS
        SUSAP KOKCK4FR17RY ADAWKS 020BEERYK4PC0E  A 020TF                    07800149    + 05000                      A JS
        SUSAP KOKCK4FR17RY ADAWKS 030ROHAAK4PC0EE B 010TF                    12220050    + 04000                      A JS
        SUSAP KOKCK4FR17RY AIFI   010IFI  K4D 0V       IF                                          18000                A JS
        SUSAP KOKCK4FR17RY AIFI   020FILUMK4PC0E  A 020TF                    11490225    + 05000                      A JS
        SUSAP KOKCK4FR17RY AIFI   030ROHAAK4PC0EE B 010TF                    17500035    + 04000                      A JS
        SUSAP KOKCK4FR17RY R      010ROHAAK4PC0E  I    IF                                + 04000    18000             A JS
        SUSAP KOKCK4FR17RY R      020IVEYIK4PC1E  F 051TF                    17500040    + 03000              RW17R K4PGA JS
        SUSAP KOKCK4FR17RY R      020IVEYIK4PC2WALPV       ALNAV/VNAV ALNAV                                             JS
        SUSAP KOKCK4FR17RY R      021COTOXK4PC0E S  031TF                    17500037    V 0180001814   -300          A JS
        SUSAP KOKCK4FR17RY R      030RW17RK4PG0GY M 031TF                    17500015      01337        -300          A JS
        SUSAP KOKCK4FR17RY R      040         0  M     CA                    1750        + 02000                      A JS
        SUSAP KOKCK4FR17RY R      050JESKEK4PC0EY  R   DF                                + 03000                      A JS
        SUSAP KOKCK4FR17RY R      060JESKEK4PC0EE  R   HM                    03620040    + 03000                      A JS
```

CITY AND STATE	ELEVATION: 1295 THRE:	FACILITY IDENTIFIER:	PROCEDURE NO./ AMDT NO./EFFECTIVE DATE:	SUP:
OKLAHOMA CITY, OK	AIRPORT NAME: WILL ROGERS WORLD	RNAV	RNAV (GPS) Y RWY 17R, AMDT 4A, 06/23/2016	AMDT: 4
				DATED: 07/24/2014

FAA FORM 8260-10 / April 2006 (Computer Generated)

PAGE 1 OF 2 PAGES


OKLAHOMA CITY, OKLAHOMA
AL-301 (FAA)
16203
WAAS CH 50102 W17A
APP CRS 175°
Rwy ldg 9801
TDZE 1282
Apt Elev 1295
RNAV (GPS) Y RWY 17R
WILL ROGERS WORLD (OKC)
For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -12°C (11°F) or above 54°C (130°F). DME/DME RNP-0.3 NA. For inop MALSR, increase LPV Cat E visibility to RVR 4000, and increase LNAV/VNAV Cat E visibility to RVR 4500. Increase LNAV all Cats visibility to RVR 5500. Simultaneous approach authorized with Rwy 17L. LNAV procedure NA during simultaneous operations. Use of FD or AP providing RNAV track guidance required during simultaneous operations.
ASR
MALSR
MISSED APPROACH: Climb to 2000 then climbing right turn to 3000 direct JESKE and hold.
ATIS 125.85
OKE CITY APP CON 124.6 266.8
ROGERS TOWER 119.35 269.45
GND CON 121.9 348.6
CLNC DEL 124.35
KINGFISHER IFI
Procedure NA for arrivals at IFI VORTAC on V140 southwest bound.
5000 115° (22.5)
4 NM
HOLD 5000
355°
175°
(IAF) FILUM
4000 175° (3.5)
(IAF) BEERY
4000 122° (5)
DAWKS
5000 078° (14.9)
(IF) ROHAA
3000 175° (4)
(FAF) IVEYI
COTOX 1.5 NM to RW17R
MSA RW17R 25 NM
3800
RW17R
JESKE
036°
216°
4 NM
2749
2749
2749±
2749
1577
2046
1608
1490
1434
1399±
1376
1631
1320
1412
1845
1881
1953
ELEV 1295
D
TDZE 1282
175° to RW17R
TWR
1436
1325
1364
1340
1317
7800 X 150
9801 X 150
9803 X 150
3078 X 75
35L
35R
TDZ/CL Rwy 35R
MIRL Rwy 13-31
HIRL Rwys 17L-35R and 17R-35L
VGSI and RNAV glidepath not coincident (VGSI Angle 3.00/TCH 60).
2000
3000
JESKE
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IVEYI
COTOX 1.5 NM to RW17R
*LNAV only
4000
3000
175°
*1 NM to RW17R
RW17R
GP 3.00°
TCH 55
*1800
4 NM
3.7 NM
0.5 NM
CATEGORY A B C D E
LPV DA 1482/24 200 (200-½)
LNAV/VNAV DA 1598/26 316 (400-⅝)
LNAV MDA 1660/24 378 (400-½) 1660/35 378 (400-¾)
C CIRCLING 1740-1 445 (500-1) 1760-1 465 (500-1) 1960-1¾ 665 (700-1¾) 2000-2¼ 705 (800-2¼) 2240-3 945 (1000-3)
OKLAHOMA CITY, OKLAHOMA
Amdt 4A 23JUN16
35°24'N-97°36'W
WILL ROGERS WORLD (OKC)
RNAV (GPS) Y RWY 17R
SC-1, 21 JUL 2016 to 18 AUG 2016

CPV Detects Coding Errors

For a one year period (June 2015-2016):

Procedure Type	Number	Coding Errors	%
RNAV (GPS)	669	39	5.8%
RNAV(RNP)	64	2	3.1%
ILS/LOC	274	29	10.6%
SID/STAR	415	15	3.6%

Common Errors

- **Segment course and distance**
- **Waypoint Latitude/Longitude**

  FTP in FAS data
- **Waypoint name differs**
- **Files missing**
- **Wrong state coded when procedure crosses state lines**

  Paper record shows same state as airport

  FMS can’t find waypoint unless coded state is correct

CPV Process

- **Manual comparison until automation is updated:**
- **The following items are compared:**
  - **Waypoint names and LAT/LON**
  - **Leg course/distance**
  - **Leg type (ARINC 424 path terminator)**
  - **FO/FB**
  - **Direction of turn**
  - **Speed**
  - **Magnetic Variation**

CPV Process

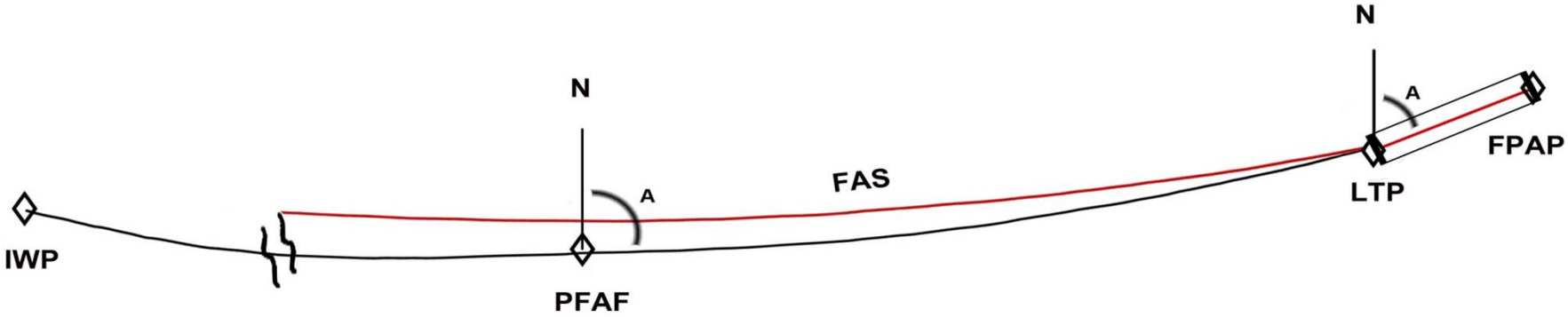
FAS DATA BLOCK INFORMATION

DATA FIELD	DATA
OPERATION TYPE	0
SBAS SERVICE PROVIDER IDENTIFIER	0
AIRPORT IDENTIFIER	KASJ
RUNWAY	RW19
APPROACH PERFORMANCE DESIGNATOR	0
ROUTE INDICATOR	
REFERENCE PATH DATA SELECTOR	0
REFERENCE PATH IDENTIFIER (APPROACH ID)	W19A
LTP/FTP LATITUDE	361813.3440N
LTP/FTP LONGITUDE	0771015.8160W
LTP/FTP ELLIPSOIDAL HEIGHT	-00147
FPAP LATITUDE	361644.1520N
FPAP LONGITUDE	0771012.8310W
THRESHOLD CROSSING HEIGHT (TCH)	00036.3
TCH UNITS SELECTOR (METERS OR FEET USED)	F
GLIDEPATH ANGLE (GPA)	03.00
COURSE WIDTH AT THRESHOLD	106.75
LENGTH OFFSET	1384
HORIZONTAL ALERT LIMIT (HAL)	40.0
VERTICAL ALERT LIMIT (VAL)	50.0
CRC REMAINDER	47E4C3F6

CPV Process

- **For approach procedures with FAS data block, PFAF-LTP course must match LTP-FPAP**
- **If it doesn't, the pilot's CDI will shift off center at the PFAF when guidance switches to the FAS data**

  Prior to this check, we rejected a procedure during flight validation in which the CDI deflected full scale at the PFAF


N
N
A
A
FAS
FPAP
LTP
IWP
PFAF

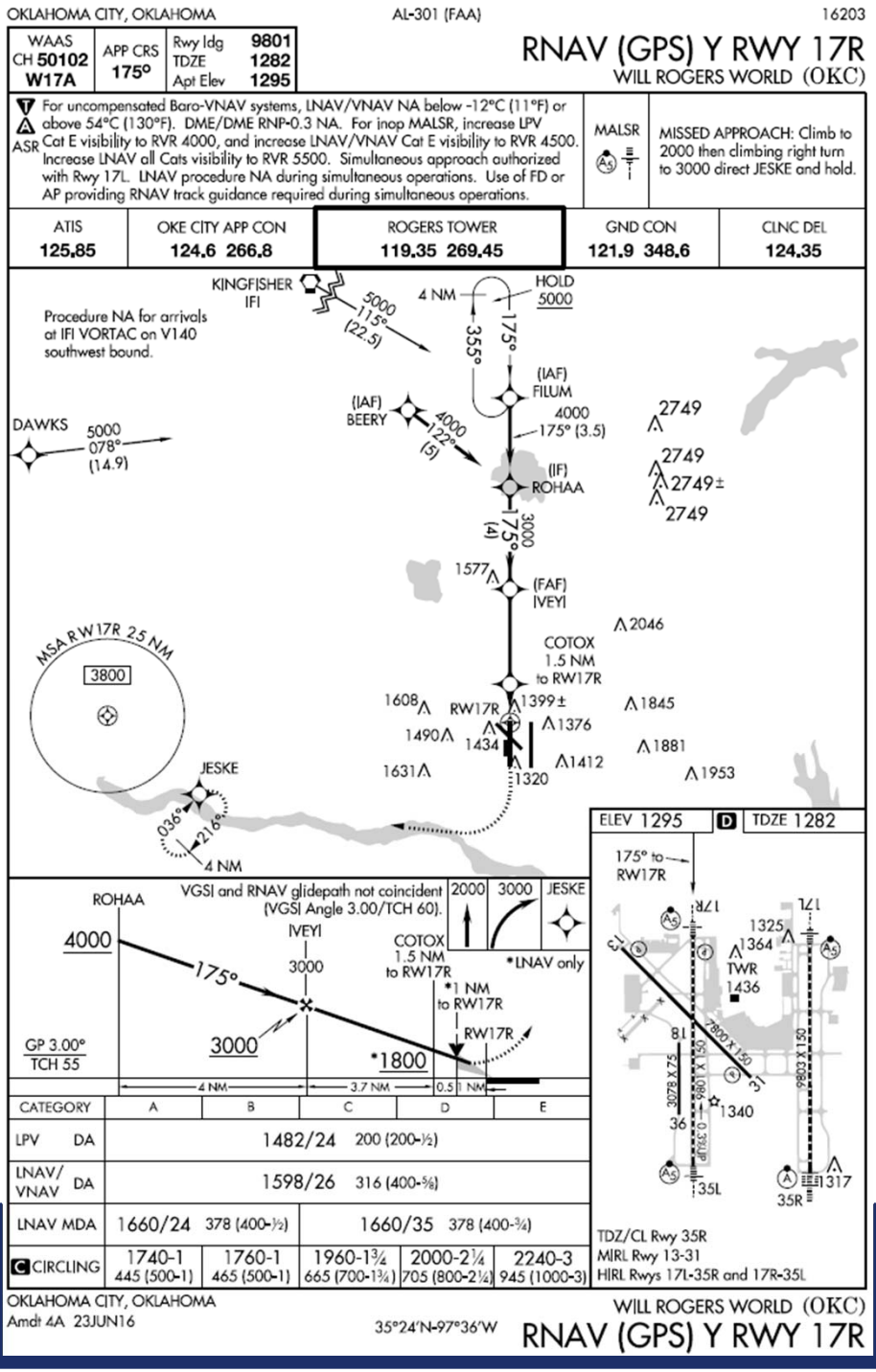
CPV Process

- **Coding packed for aircraft FMS use is flown using PC simulation software provided by Universal and Collins**
- **Complex procedures are flown in full scale Level C or D flight simulators: Boeing 737 and Airbus A300**
  - **RF segments (curved path)**
  - **Higher than standard descent gradients**
  - **Multiple altitude and/or airspeed restrictions**
  - **Waiver to FAA criteria**
  - **Intermediate segment offset from final segment**

SBAS Flight Inspection

Objectives:

- Approach delivers aircraft to a position from which a landing can be made
- Obstacle clearance
  - 34:1 surface must be clear for 200 HAT LPV procedure
  - Flight Inspection is not required for segments at or above Minimum IFR Altitudes
- Communications
  - Flight Inspection is not required if there are existing procedures in the same area at the same or lower altitudes.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APP CRS 175°
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RNAV (GPS) Y RWY 17R
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4 NM
HOLD 5000
355°
175°
5000 115° (22.5)
(IAF) FILUM
(IAF) BEERY
4000 122° (5)
4000 175° (3.5)
DAWKS
5000 078° (14.9)
(IF) ROHAA
175° (4) 3000
(FAF) IVEYI
COTOX 1.5 NM to RW17R
MSA RW17R 25 NM
3800
JESKE
036°
216°
4 NM
RW17R
2749
2749
2749±
2749
1577
2046
1608
1399±
1845
1490
1434
1376
1881
1631
1320
1412
1953
ELEV 1295
D
TDZE 1282
175° to RW17R
1325
1364
TWR
1436
1340
1317
35L
35R
TDZ/CL Rwy 35R
MIRL Rwy 13-31
HIRL Rwys 17L-35R and 17R-35L
VGSI and RNAV glidepath not coincident (VGSI Angle 3.00/TCH 60).
2000
3000
JESKE
*LNAV only
ROHAA
4000
175°
IVEYI
3000
COTOX 1.5 NM to RW17R
*1 NM to RW17R
RW17R
GP 3.00°
TCH 55
3000
*1800
4 NM
3.7 NM
0.5 NM
CATEGORY A B C D E
LPV DA 1482/24 200 (200-½)
LNAV/VNAV DA 1598/26 316 (400-⅝)
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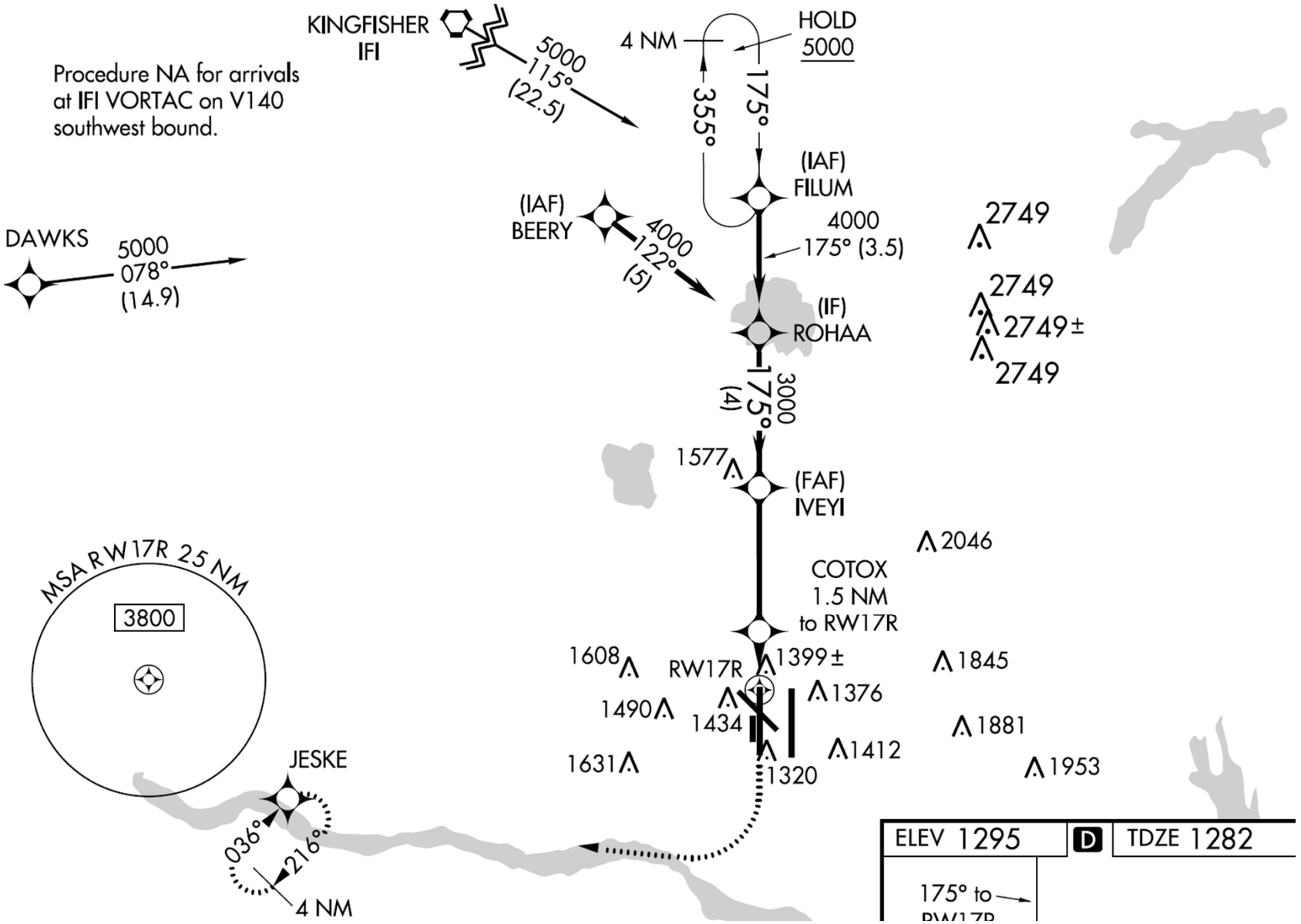
Amdt 4A 23JUN16
35°24'N-97°36'W
WILL ROGERS WORLD (OKC)
RNAV (GPS) Y RWY 17R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4 NM
HOLD
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355°
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DAWKS
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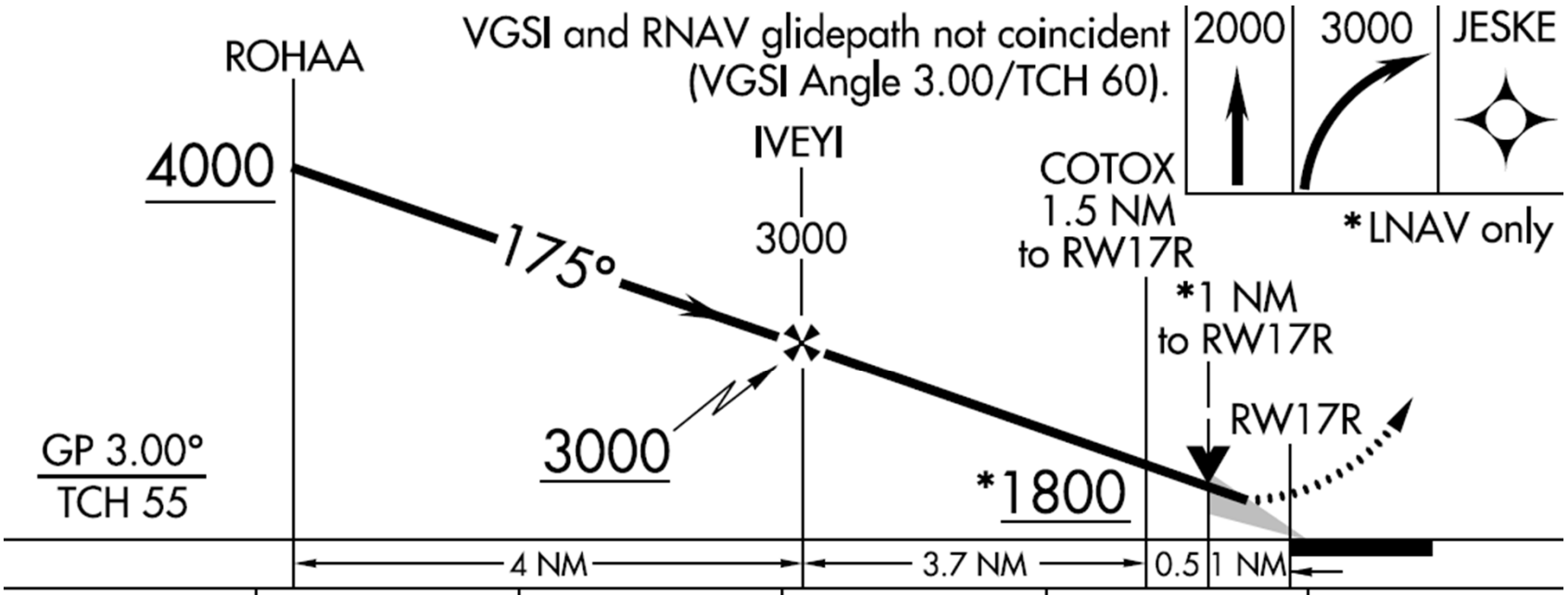
078°
(14.9)
(IAF)
BEERY
4000
122°
(5)
(IF)
ROHAA
3000
175°
(4)
1577
(FAF)
IVEYI
2749
2749
2749±
2749
2046
COTOX
1.5 NM
to RW17R
1608
RW17R
1399±
1845
1376
1490
1434
1881
1412
1631
1320
1953
MSA RW17R 25 NM
3800
JESKE
036°
216°
4 NM
ELEV 1295
D
TDZE 1282
175° to



CATEGORY	A	B	C	D	E
LPV DA	1482/24 200 (200-½)				
LNAV/ VNAV DA	1598/26 316 (400-⅝)				
LNAV MDA	1660/24 378 (400-½)		1660/35 378 (400-¾)		
C CIRCLING	1740-1 445 (500-1)	1760-1 465 (500-1)	1960-1¾ 665 (700-1¾)	2000-2¼ 705 (800-2¼)	2240-3 945 (1000-3)

STANDARD INSTRUMENT APPROACH PROCEDURE DATA RECORD

PART - A OBSTRUCTION DATA

1. APP SEGMENT	FROM	TO	OBSTRUCTION	COORDINATES	ELEV. MSL	ROC	ALT. ADJUSTMENTS	MIN. ALT.
FEEDER	IFI VORTAC	FILUM	1. TOWER (40-002238)	354338.00N/0975231.00W	2045 (5D)	1000	AT1955	5000
			2. TERRAIN	354124.00N/0975012.00W	1359 (1400)		AS1500	2900
FEEDER	DAWKS	BEERY	3. TOWER (40-002260)	353649.00N/0975221.00W	2282 (5D)	1000	AT1718	5000
			4. TERRAIN	353621.00N/0980030.00W	1424 (1400)		AS1500	2900
INITIAL	BEERY	ROHAA	5. TOWER (40-020546)	353413.06N/0974125.32W	1538 (2C)	1000	AT1462	4000
			6. TERRAIN	353336.00N/0973412.00W	1231 (1200)		AS1500	2700
INITIAL	FILUM	ROHAA	7. TANK (40-001105)	353500.00N/0973507.00W	1451 (2C)	1000	AT1549	4000
			8. TERRAIN	353239.00N/0973418.00W	1241 (1200)		AS1500	2700
INTERMEDIATE	ROHAA	IVEYI	9. TOWER (40-000766)	352953.00N/0973710.00W	1577 (1A)	500	AT923	3000
			10. TERRAIN	352924.00N/0973530.00W	1267 (1300)		AS1500	2800
FINAL: LPV	IVEYI	RW17R				ASC		1482/200
FINAL: LNAV/VNAV	IVEYI	RW17R	11. TREE	352449.00N/0973608.00W	1399 (2C)	PDA	MA18 AC20	1598/316
FINAL: LNAV	IVEYI	COTOX/1.50 NM TO RW17R	12. TOWER (40-001587)	352847.46N/0973630.06W	1536 (2C)	250		1800
2. PROCEDURE TURN								
3. MISSED APPROACH MAP:	DA / DA / RW17R	JESKE	13. TANK (KOKC0029)	352357.93N/0973719.94W	1434 (1B)	ASC	AC10	3000
			14. TOWER (40-001025)	352326.80N/0974524.69W	1710 (1A)	1000		2800
ELEV:	1314/1467/1560		15. TERRAIN	352309.00N/0974109.00W	1395 (1400)		AS1500	2900

4. CIRCLING AREA	DISTANCE	HT. ABV. ARPT. REQUIRED	HT. ABV. ARPT. ACTUAL		OBSTRUCTION	COORDINATES	ELEV. MSL	ROC	ALT. ADJUSTMENTS	MIN. ALT.
CATEGORY A	1.3 NM	350	445		16. TOWER (40-020361)	352353.42N/0973600.87W	1436 (1A)	300		1740
CATEGORY B	1.5 NM	450	465		16. TOWER (40-020361)	352353.42N/0973600.87W	1436 (1A)	300	HAA	1760
CATEGORY C	1.7 NM	450	665		17. TOWER (40-001570)	352445.00N/0974027.00W	1608 (5D)	300	AC50	1960
CATEGORY D	2.3 NM	550	705		18. TOWER (40-002667)	352218.00N/0974027.00W	1631 (5D)	300	AC50	2000
CATEGORY E	4.5 NM	550	945		19. TOWER (40-000009)	352314.00N/0972957.00W	1881 (1D)	300	AC50	2240

5. MINIMUM SAFE ALTITUDES — PRIMARY NAVAID: RW17R

SECTOR	OBSTRUCTION	BRG/DIST	ELEVATION (MSL)	M S A	SECTOR	OBSTRUCTION	BRG/DIST	ELEVATION (MSL)	M S A
360-360	TWR (40-000866)	029/10.3	2749 (4D)	3800					

CITY AND STATE		FACILITY	PROCEDURE AND AMENDMENT NO:	REGION
OKLAHOMA CITY, OK	ELEVATION: 1295 AIRPORT NAME: WILL ROGERS WORLD	RNAV	RNAV (GPS) Y RWY 17R, AMDT 4A, 06/23/2016	ASW

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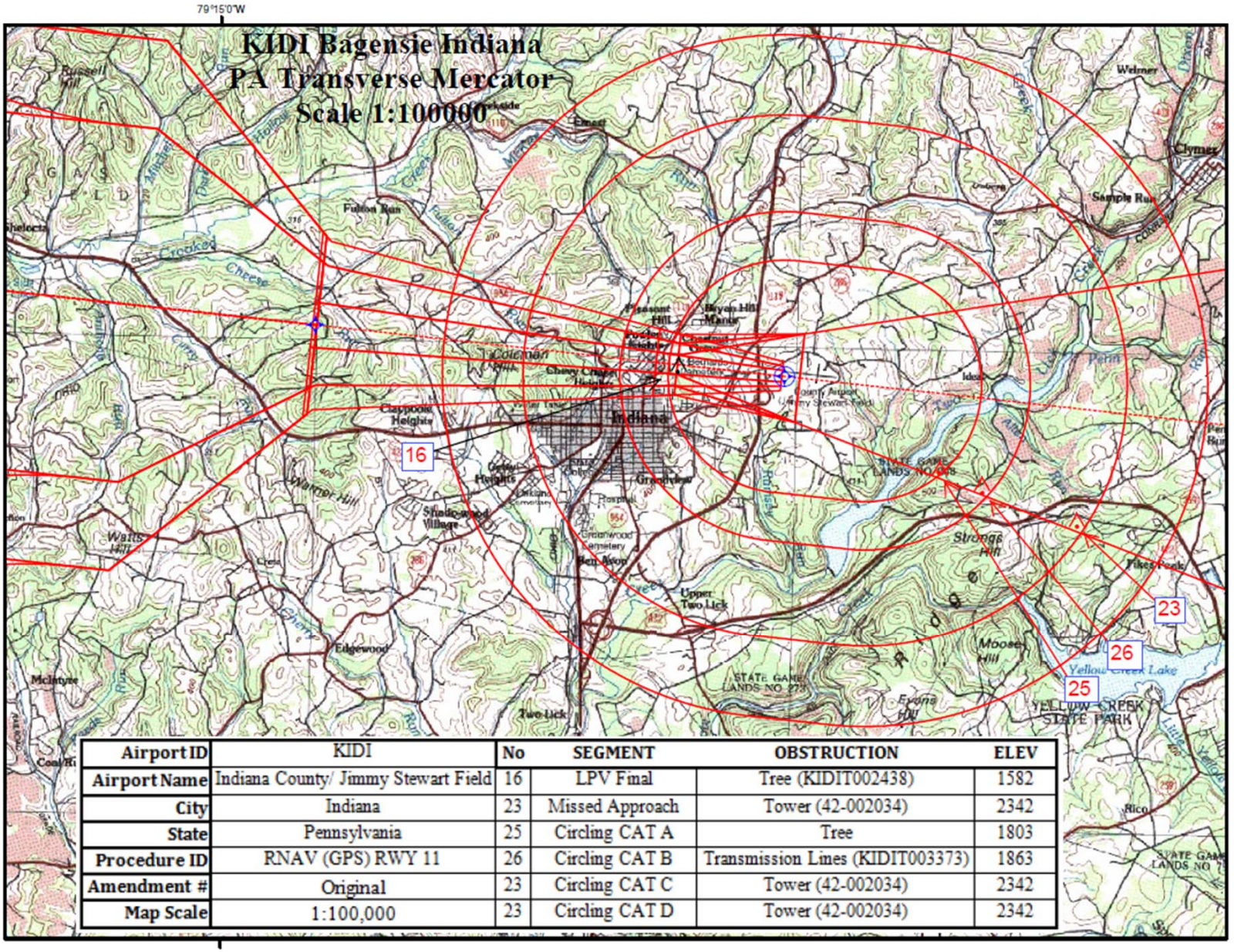

Airport ID	KIDI	No	SEGMENT	OBSTRUCTION	ELEV
Airport Name	Indiana County/ Jimmy Stewart Field	16	LPV Final	Tree (KIDIT002438)	1582
City	Indiana	23	Missed Approach	Tower (42-002034)	2342
State	Pennsylvania	25	Circling CAT A	Tree	1803
Procedure ID	RNAV (GPS) RWY 11	26	Circling CAT B	Transmission Lines (KIDIT003373)	1863
Amendment #	Original	23	Circling CAT C	Tower (42-002034)	2342
Map Scale	1:100,000	23	Circling CAT D	Tower (42-002034)	2342

SBAS Flight Inspection

- **FAS Data Block Validation**
  - **For SBAS, this data is in the FMS database**
  - **Landing Threshold Point (LTP) and Flight Path Alignment Point (FPAP) define the approach course**
  - **LTP ellipsoid height and threshold crossing height define the GNSS elevation that the glidepath crosses runway threshold**

FAS Data Block

DATA FIELD	DATA
OPERATION TYPE	0
SBAS SERVICE PROVIDER IDENTIFIER	0
AIRPORT IDENTIFIER	KOKC
RUNWAY	RW17R
APPROACH PERFORMANCE DESIGNATOR	0
ROUTE INDICATOR	Y
REFERENCE PATH DATA SELECTOR	0
REFERENCE PATH IDENTIFIER (APPROACH ID)	W17A
LTP/FTP LATITUDE	352421.4190N
LTP/FTP LONGITUDE	0973620.6020W
LTP/FTP ELLIPSOIDAL HEIGHT	+03640
FPAP LATITUDE	352244.5000N
FPAP LONGITUDE	0973620.5100W
THRESHOLD CROSSING HEIGHT (TCH)	00055.0
TCH UNITS SELECTOR (METERS OR FEET USED)	F
GLIDEPATH ANGLE (GPA)	03.00
COURSE WIDTH AT THRESHOLD	106.75
LENGTH OFFSET	0000
HORIZONTAL ALERT LIMIT (HAL)	40.0
VERTICAL ALERT LIMIT (VAL)	35.0
CRC REMAINDER	E4F62C96

SBAS Tolerances

Horizontal Protection Level (HPL)	**<= 40 meters**
Vertical protection Level (VPL)	**<= 35 meters (200-249 DA)**
	<= 50 meters (>= 250 DA)
CRC Remainder	**Perfect Match**
Course Alignment	**+- 0.1 degrees of true course**
Glide Path Alignment	**+- 0.09 degrees**
Threshold Crossing Height	**+12 ft / -10 ft**

SBAS Data Logging

These parameters are documented in the Intermediate and Final Approach Segments and whenever anomalies are found:

Parameter	Expected Value
HPL	<= 40 meters
VPL	<= 50 meters (<= 35 for 200 DA)
HDOP/VDOP	1.0 – 1.5
Healthy Satellites	4 GPS & 1 GEO minimum
Tracked Satellites	4 GPS & 1 GEO minimum
Geostationary Satellite SNR	>= 30 dB/Hz
Sensor Status	SBAS

GBAS Flight Inspection

Ground checks

- **PVT mode enabled**
- **VDB power decreased to alarm level**
- **VDB signal strength, interference, LPL, VPL, FAS data block (message type 4), facility information (message type 2)**
- **Pilot checks each GBAS channel to insure course guidance is available and RPI is correct**
- **VDB dual channel, if installed**

GBAS Airborne Checks

- **Coverage**
  - **23 nm at 2500 ft above VDB antenna**
  - **2500 ft level run from 20 nm**
  - **5 approaches from 20 nm thru runway threshold**
    - **Bracket above and below GP**
    - **Bracket left and right of centerline**
  - **Runway rollout**

GBAS Airborne Checks

- **Polarization**
  - **VDB may be horizontally (GBAS/H) or elliptically (GBAS/E) polarized**
- **FAS Data Block Validation**
  - **For GBAS, this data is part of the VHF Data Broadcast**
  - **Landing Threshold Point (LTP) and Flight Path Alignment Point (FPAP) define the approach course**
  - **LTP ellipsoid height and threshold crossing height define the GNSS elevation that the glidepath crosses runway threshold**

FAS Data Block

18 data elements that define the final approach course and glide path:

Operation Type	0		
Airport Identifier	KIAH		
Runway	RW08L		
Approach Performance Designator	1		
Reference Path Data Selector	2		
Reference Path Identifier	GBZU		
LTP Latitude	3000025.7780N		
LTP Longitude	0952131.6470W		
LTP Ellipsoid Height	+00005		
FPAP Latitude	300025.8600N		
FPAP Longitude	0951949.0300W		
Threshold Crossing Height	00059.0		
TCH Units Selector (Meters or Feet)	F		
Glide Path Angle (GPA)	03.00	Length Offset	00008
Course width at Threshold	106.75	CRC Remainder	0AB8904E
GBAS Service Provider	14		

GBAS Tolerances

Reference Path Identifier	**Exact Match**	
FAS Data CRC	**Exact Match**	
Glide path Angle	**+/- 0.05 degrees**	
Lateral Alignment	**+/- 0.1 degree true course**	
Threshold Crossing height	**+/- 2 meters**	
Message Type 4 Alert Limits		
FAS Lateral Alert Limit	**40 meters**	
FAS Vertical Alert Limit	**10 meters**	
	Values apply at 200 ft DA to LTP	
Coverage	**HP**	**VP**
CCW Orbit	**-78 dBm**	**-86 dBm**
CW Orbit	**-81 dBm**	**-85 dBm**
Inbound	**-87 dBm**	**-93 dBm**
Outbound	**-80 dBm**	**-74 dBm**

Interference

Interference must not cause an out-of-tolerance condition or loss of GBAS data continuity.

GBAS Issues

Problem: Receivers don't report signal strength

Solution: Pay for red label (not certified for IFR use) receiver

Collins GNLU-955M signal strength step size is 1 dB

A competing receiver could only provide 6 dB steps

Problem: Signal strength is difficult to calibrate. Ground measurements differ from those in flight. Radiation pattern is not symmetrical.

Solution: We calibrated in flight for azimuths 0, 90, 180, 270

Future Enhancements

FIAPA (Flight Inspection Airborne Processor Application) is the FAA's next generation flight inspection system. It will be used for ground based flight inspection starting in March 2017.

FIAPA has three GNSS/SBAS sensors: Collins GPS-4000S, Collins GNLU-955M, and Spectra Precision ProFlex 800

FIAPA analyzes deviation outputs, eliminating the need to place the GBAS ground facility in PVT mode.

FIAPA will be enhanced to analyze GAST-D (CAT II/III) by June 2018.

FAA Academy Classes

The following classes are offered in the next year:

15310001 Basic PANS-OPS

Introduction and Ground Based Navaids

5 weeks; 3 April – 5 May 2017; $5615

15320002 PBN PANS-OPS – RNAV & RNP

3 weeks; 5-23 June 2017; $3963

15300051 Airspace System Inspection Pilot/Tech

3 weeks; 23 Jan – 10 Feb 2017; $6514

Basic PANS-OPS

For design of instrument approach procedures and evaluation/ approval of procedures

Content

- **ICAO Documentation (PANS-OPS, Doc 8168, Construction Manual, Charting Manual, Annex 4, 10, 11, 14)**
- **General Criteria**
- **Non-Precision Approach**
- **Precision Approach**
- **Conventional Instrument Departures**
- **Helicopter Procedures**

PBN PANS-OPS

For design or evaluation of RNAV/GNSS/RNP based procedures.

Content

- **Area Navigation**
- **GNSS**
- **Vertical Navigation (VNAV)**
- **Augmented GNSS (SBAS, GBAS)**
- **RNP**
- **RNAV/GNSS/RNP Departures**
- **Flight Validation of Procedures**

International Flight Inspection

Covers basic procedures from US Flight Inspection Manual

This is a non-flying course, not including Automated Flight Inspection System. It includes laboratory exercises.

Content

- **Radar principles**
- **ASR and PAR Flight Inspection Methods**
- **Non-Directional Beacons**
- **VORTAC Principles, Data Analysis, Methods, and Planning**
- **GPS System Flight Inspection**

International Flight Inspection

Content (Continued)

- **Non-Directional Beacons**
- **Localizer and Glide Slope Principles**
- **ILS Flight Inspection Methods and Planning**
- **Marker Beacons**
- **Instrument Approach Procedures**
- **Airport Lighting Systems**
- **NOTAMS**

FAA Academy Classes

Classes are taught in English

Classes may be presented at your location

International Training website:

https://www.academy.jccbi.gov/catalog/international/contents/TERPS.html

Contact: steve.blue@faa.gov

Questions?