中国民用航空飞行校验中心
FLIGHT INSPECTION CENTER OF CAAC

Flight Testing of GBAS in Tianjin Airport

Liu Shuming
Flight Inspection Center of CAAC, China
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Introduction

During the past 4 years, Flight Inspection Center of CAAC has made several flight tests for the certification of GBAS ground equipment LGF-1A(at Tianjin airport) and SLS-4000(at Pudong airport).

The flight tests theory and method are the same, and the flight tests at Tianjin airport is introduced here.

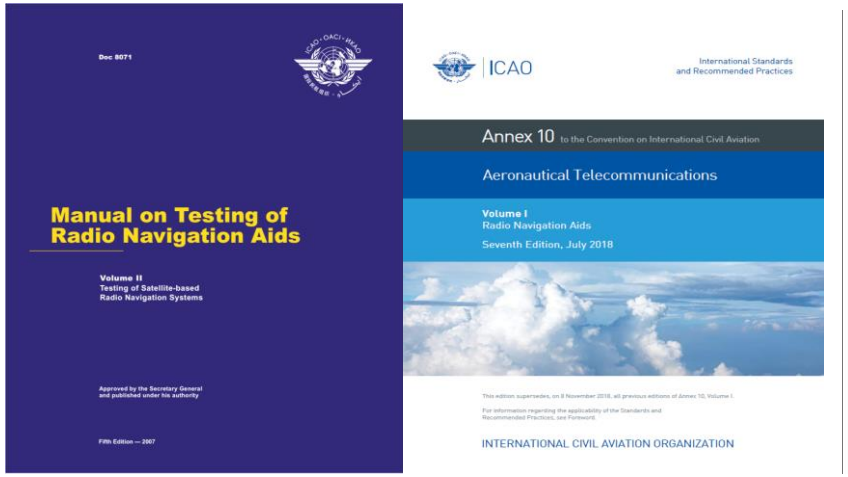
Contents

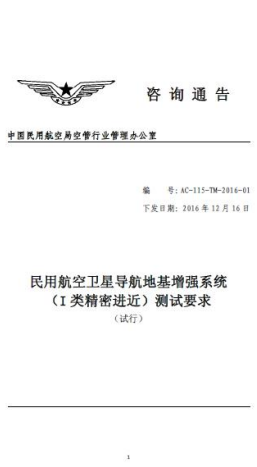
中国民用航空飞行校验中心
FLIGHT INSPECTION CENTER OF CAAC

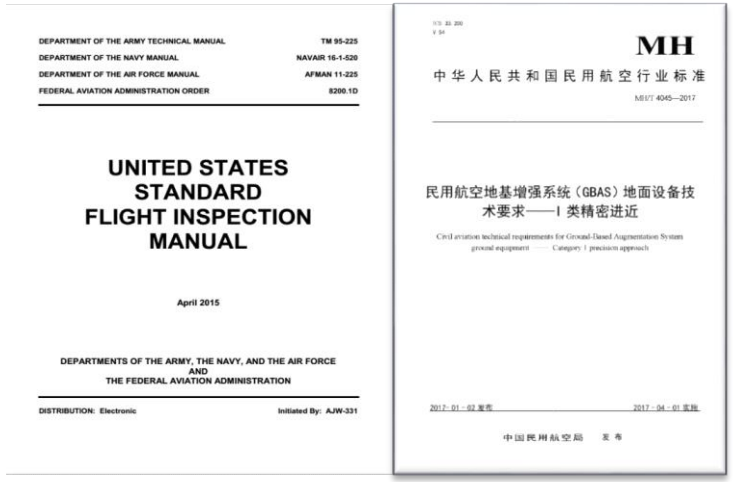
01 GBAS Flight Testing Standards

Standards

- ICAO ANNEX 10
- ICAO DOC-8071 Volume II
- FAA DOC-8200.1D
- Testing Requirements for GBAS (Cat-I PA) CAAC
- Technical Requirements for GBAS ground equipment (Cat-I PA) CAAC







1.1 Flight tests of GBAS are required when:

- Commissioning
- Interference
- Procedure modification or the introduction of a new procedure
- Changes occur to the GBAS configuration
- Site changes
- Following certain maintenance activities
- **Certification**

1.2 Preparation for flight testing

1. Measure runway coordinates, VDB antenna position, and verify the coordinates and height of the DGPS station reference point required by the inpection aircraft.

Runway length	
Magnetic variation	
VHF frequency	
GLS channel	
VDB position	
RTK reference point	

2. GBAS Procedure

3. FAS DATA

Data Content	
Airport ID	
Runway Number	
LTP Latitude	
LTP Longitude	
LTP Height	
FPAP Latitude	
FPAP Longitude	
Approach Threshold Crossing Height (TCH)	
Glide Path Angle (GPA)	

1.3 Parameters

Table II-4-4. Summary of minimum flight test requirements — GBAS

Parameter	*Annex 10 Volume I reference*	*Doc 8071 Volume II reference*	*Measurand*	*Tolerance/ Limit*	*Uncertainty*	*Periodicity*
FAS data	App.B 3.6.4.5	4.3.4	FAS path	Consistent with FAS design	N/A	C, Sp
Procedure Validation	(none)	5.3	N/A	N/A	Subjective	C, Sp
Resistance to Interference (Ranging Signal)	App. B 3.7	4.3.6	Interference signal level	< interference mask definitions	±3 dB	C, Sp
VDB Coverage GBAS/H field strength GBAS/E field strength Horizontal Vertical	3.7.3.5.4.4	4.3.7 to 4.3.10	Field strength	 >-99 dBW/m^2 to –35 dBW/m^2 >-99 dBW/m^2 to –35 dBW/m^2 –103 dBW/m^2 to –39 dBw/m^2	±3 dB	C, Sp
Message block header (GBAS identification only)	App. B 3.6.3.4.1	4.3.14	Facility Identification	Exact Match	N/A	C, Sp
Data content (operational)	App. B 3.6.4	4.3.15 to 4.3.16	Message Data Content	Exact Match	N/A	C, Sp
Position Domain Accuracy (optional)	(none)	4.3.17 to 4.3.18	Position	4 m vertical / 16m lateral	1m	C, Sp

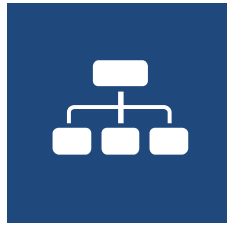
Notes:

1. *N/A = Not Applicable.*
   C = Commissioning (and when published design changes to the procedure occur).
   Sp = Special, e.g. when interference is suspected or a periodic interference check is desired.
2. *If periodic checks are desired, parameters and intervals will be determined by individual States.*

1.3 Parameters

FAS Data Block Validation

The FAS data received by the receiver is consistent with the published data.



VDB Coverage

Within the minimum required GBAS coverage volume of each final approach segment served, the minimum and maximum VDB field strength requirements must be met.

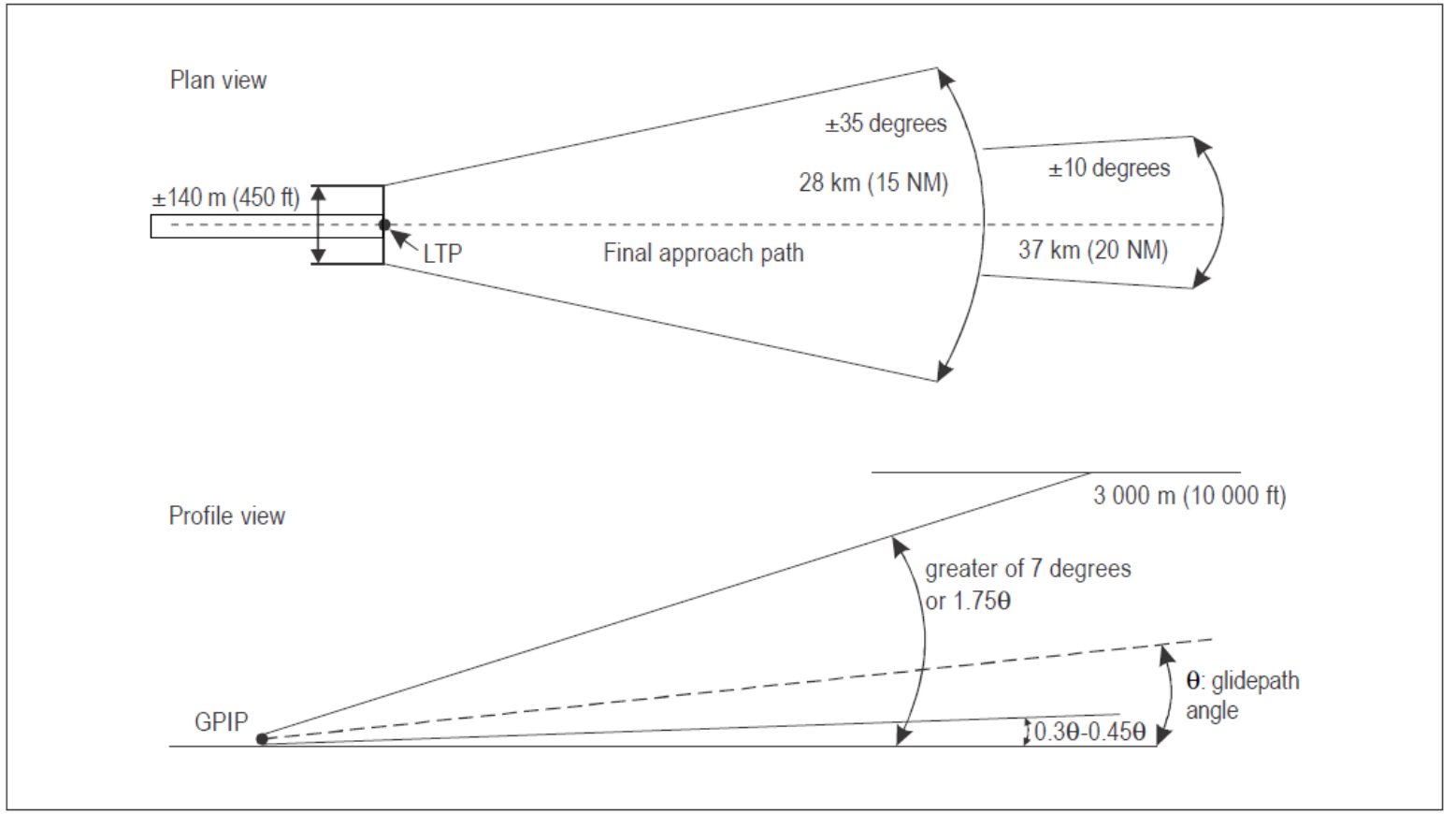
Approach Procedure Validation

Guide accuracy meets the requirements of precision approach.

GNSS signals

GPS satellite number, signal to noise ratio and DOP value during flight.

VDB Service volume



GPIP — glide path intersection point
LTP — landing threshold point

VDB field strength

8071 Requirements

GBAS/H field strength	>-99dBW/m^2 to -35dBW/m^2
GBAS/E field strength	
Horizontal	>-99dBW/m^2 to -35dBW/m^2
Vertical	>-103dBW/m^2 to -39dBW/m^2

GPS Satellite Parameters

Parameter	Expected Values
LPLGBAS	≤ 40m (1), ≤ 69.15m Max
VPLGBAS	≤ 10m (1), ≤ 43.35m Max
HDOP	≤ 4.0
VDOP	≤ 4.0
HIL	≤ 0.3nm
FOM	≤ 22meters
Satellites Tracked	5 Minimum
Signal-to-Noise Ratio (SNR)	30 dB/ Hz minimum

Note: There are no flight inspection tolerances applied to these parameters. However, they may provide useful information should GPS signal anomalies or interference be encountered.

The question proposed at the meeting yesterday:

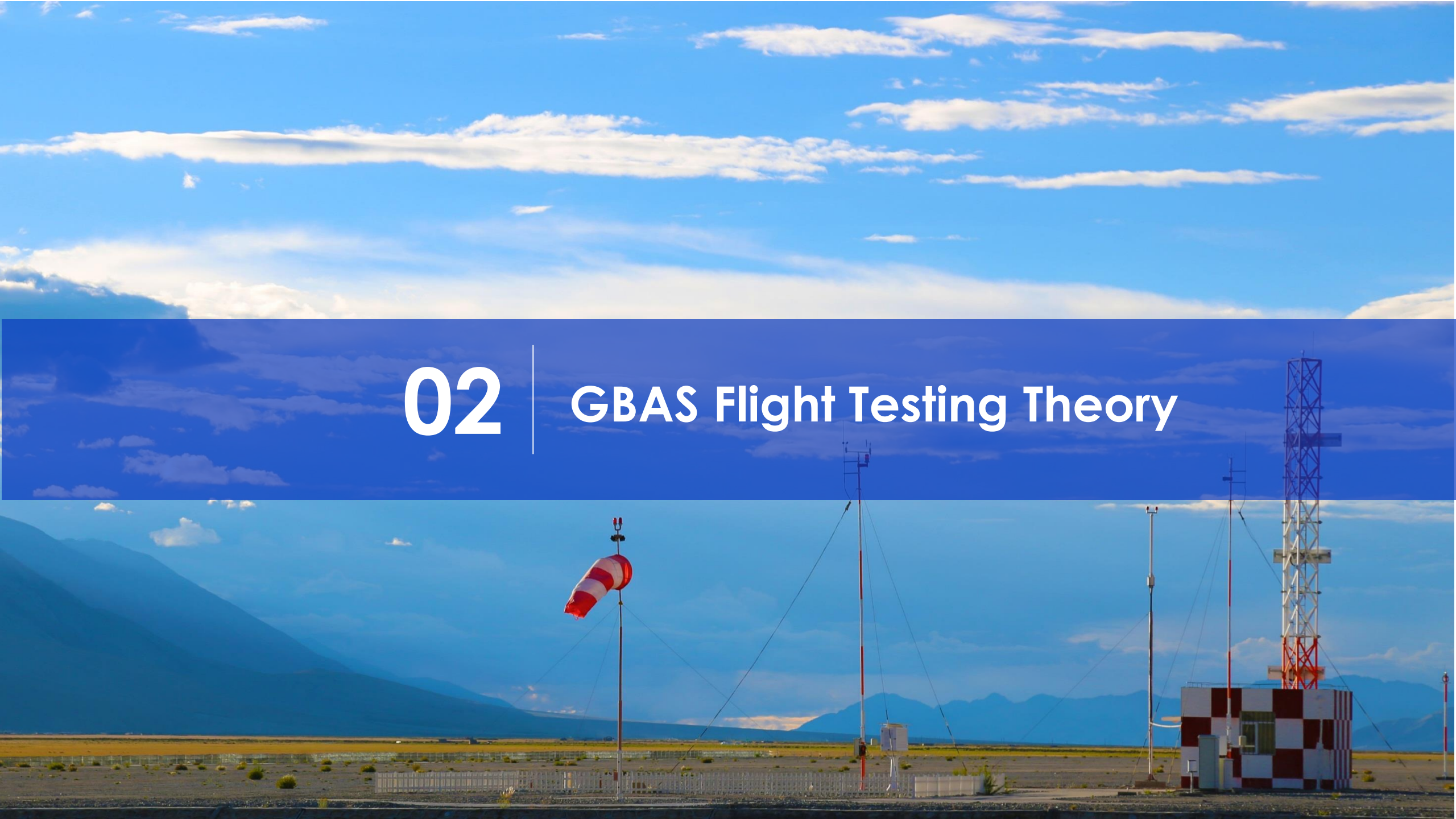
Could you provide more detailed explanation on "Check GNSS Signal Quality" in p.5 and 6 (Requirements of GBAS and SBAS)? Could you specify which part of Doc 8071 requires this?

In-flight activities

Procedure validation

Resistance to interference (ranging signal)

4.3.6 GBAS receiver standards require that receivers not provide hazardously misleading information in the presence of radio frequency interference. Excessive ranging signal interference will therefore affect continuity and availability, rather than integrity. The loss of GBAS correction signals and/or the loss of guidance have proven to be good indicators of probable GNSS and/or GBAS interference. If interference is suspected, further investigation should be conducted. Some States may require a pre-commissioning survey of the interference environment. The suspected area should be probed and spectrum analysis accomplished to define its geographical extent. GNSS and GBAS parameters such as carrier-to-noise density (C/No), horizontal and vertical protection levels, satellites tracked, and DOP should be documented to aid further investigation. If interference is confirmed, the appropriate action should be taken,



02 GBAS Flight Testing Theory

02 GBAS Flight Testing Theory

VDB STATION

GBAS DATA

GPS Differential correction data

FAS DATA BLOCK

GNLU-930 Multimode Receiver

MMR Receiver

RTK STATION (FIS)

DGPS DATA

FIS Software

Horizontal vertical deviation information

FAS DATA

Calculate deviation informati on

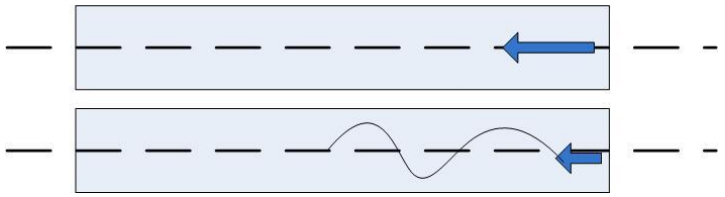
Output The Result

03 Flight Testing Procedure and Method

Reasons for choosing Tianjin Airport:

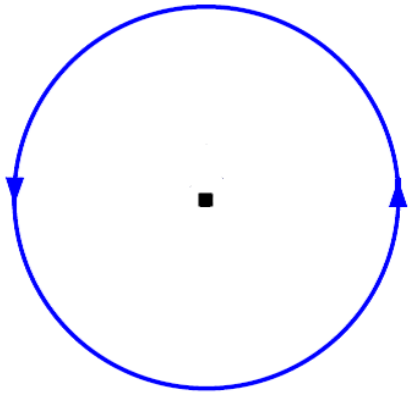
1. The amount of flights is moderate.
2. The dual runway verifies the ability of a GBAS facility to cover multiple directions of multiple runways.
3. Airspace resources are relatively constrained , and GBAS can optimize flight procedures after installation, which can solve the problem of flight flow control that may be faced in the future.
4. Located in the plain, the transportation is convenient, there is no special demand for the construction of the project, which is conducive to the implementation of the project and equipment testing.

03 Flight Testing Procedure and Method



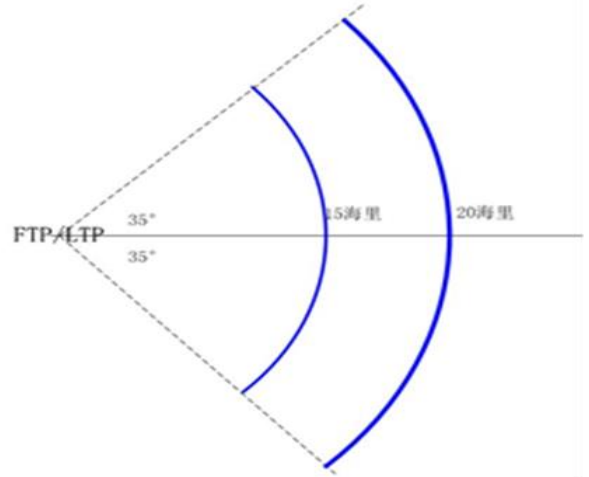
Ground taxiing

Check item:
FAS Data Validation , Verifying course Deviation
VDB Coverage



Orbit

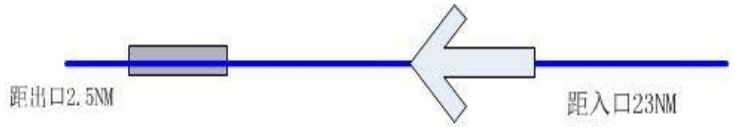
Flight method:
Take the FTP/LTP (landing entry point) as the center, the flight height is 1500m, 3000m, and the radius is 20 NM.
Check item:
Coverage and interference of VDB signals.

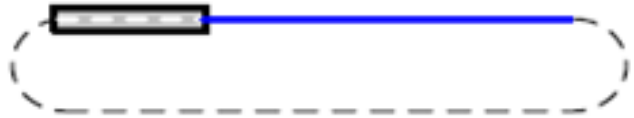


Arcs

Flight method:
Fly an arc ±10 degrees across the extended Final Approach Segment course at 37 km
(20 NM) from the FTP/LTP. Fly an arc ±35 degrees across the extended Final Approach Segment at 28 km (15 NM).
Check item:
Coverage of the VDB signal in the approach direction

03 Flight Testing Procedure and Method





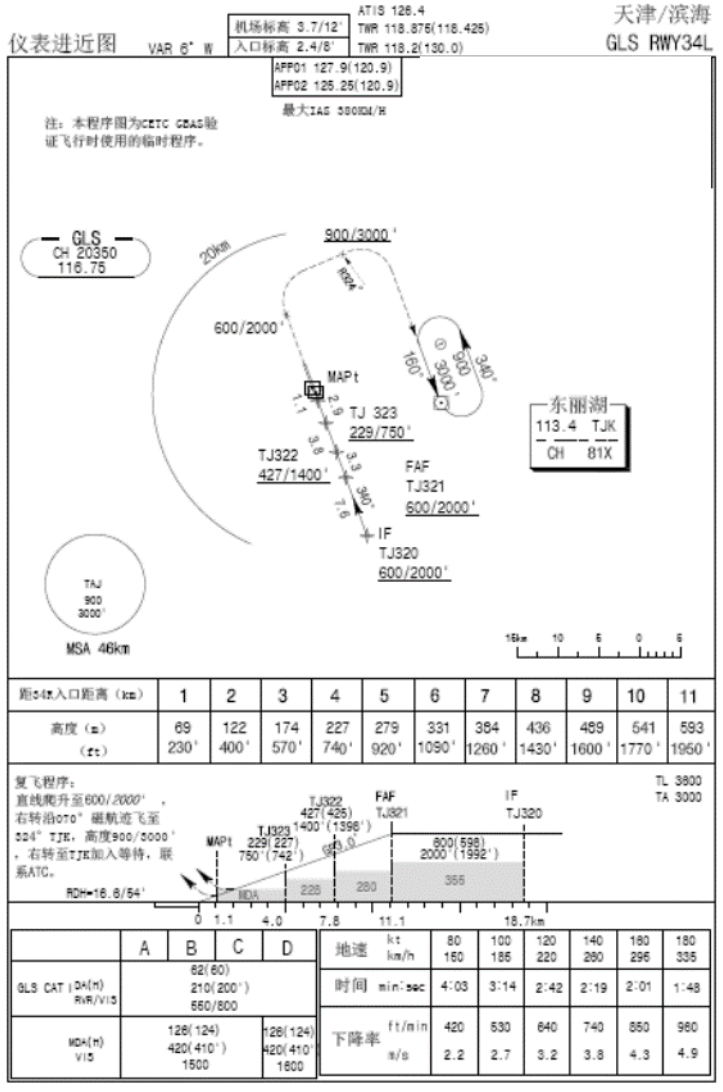
LEVEL RUN

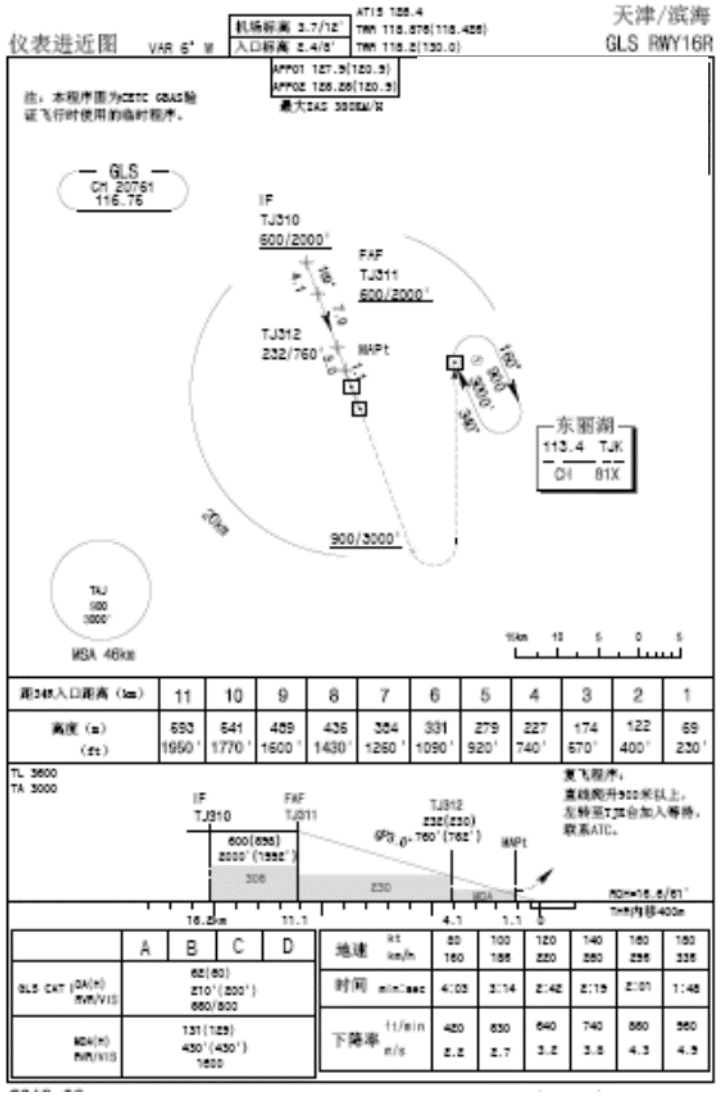
Flight method:
The flight inspection aircraft flies towards the FTP at 3000m height, following the localizer center line, commencing at a distance of 23NM and ends at 2.5NM.
Check item:
VDB signal coverage in approach segment.

APPROACH

Flight method:
Proceed inbound along the final approach course following the procedure. Intercept the glidepath and fly to an altitude of 30 m (100 ft).
Check item:
VDB signal coverage and DGPS positioning accuracy in the approach direction.
Validation of flight procedure and missed approach procedure.

GLS PROCEDURE

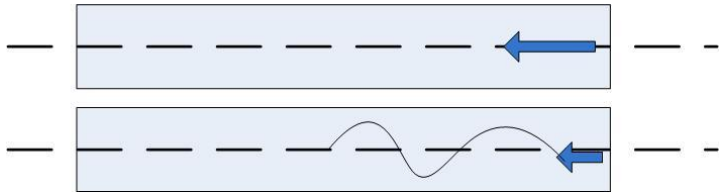




03 Flight Testing Procedure and Method

01

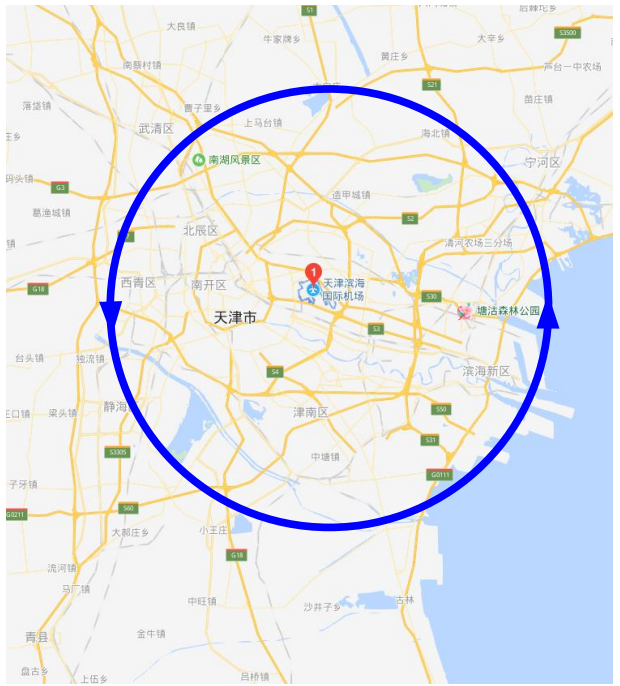
RWY 16R、34L



Flight method	1、Runway round-trip 2、Taxiing along the centerline of the runway 3、S-Line Taxiing along the centerline of the runway
Check item	1、Signal reception, record field strength 2、FAS Data Validation , Verifying course deviation 3、VDB Coverage

02

RWY 16R、34L



Flight method	Take the FTP/LTP (landing entry point) as the center, the flight height is 1500m, 3000m, and the radius is 20 NM.
Check item	Coverage and interference of VDB signals.

03 Flight Testing Procedure and Method

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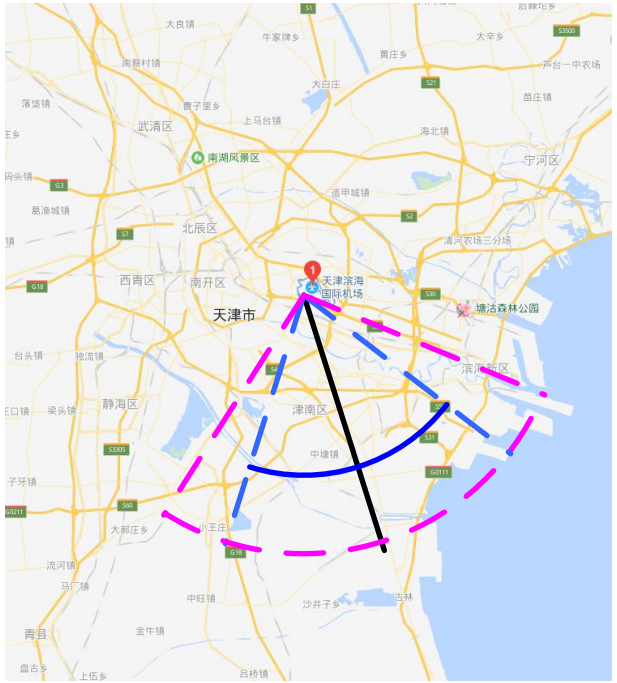
03

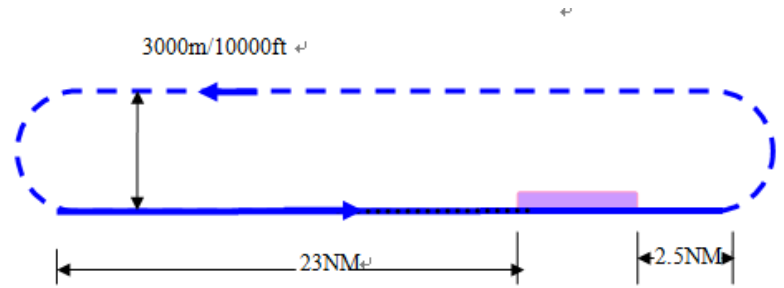
RWY 34L



Flight method	Fly an arc ±10 degrees across the extended Final Approach Segment course at 37 km (20 NM) from the FTP/LTP. Fly an arc ±35 degrees across the extended Final Approach Segment at 28 km (15 NM).
Check item	Coverage of the VDB signal in the approach direction

04

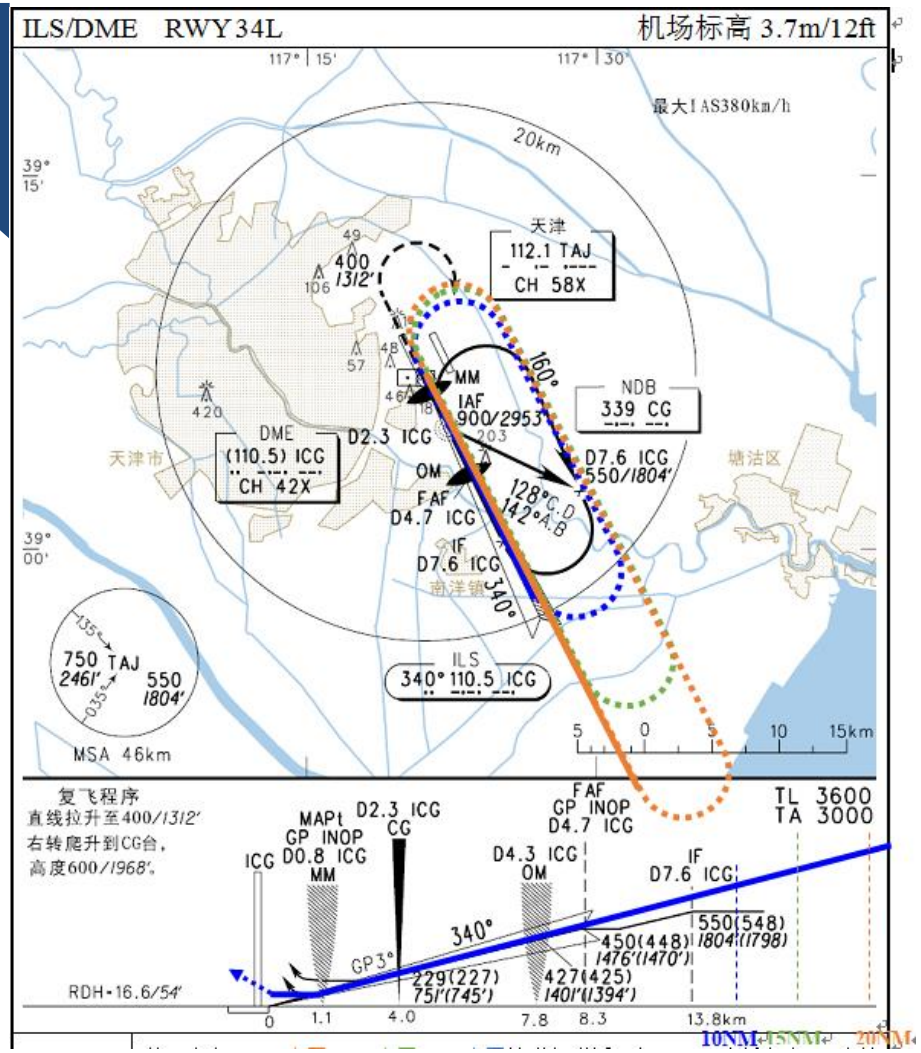
RWY 16R、34L



Flight method	The flight inspection aircraft flies towards the FTP at 3000m height, following the localizer center line, commencing at a distance of 23NM and ends at 2.5NM.
Check item	VDB signal coverage in the approach segment.

03 Flight Testing Procedure and Method

05



Flight method	Proceed inbound along the final approach course following the procedure. Intercept the glidepath and fly to an altitude of 30 m (100 ft).
Check item	VDB signal coverage and DGPS positioning accuracy in the approach direction Validation of flight procedure and missed approach procedure

04 Conclusion and Data Analysis

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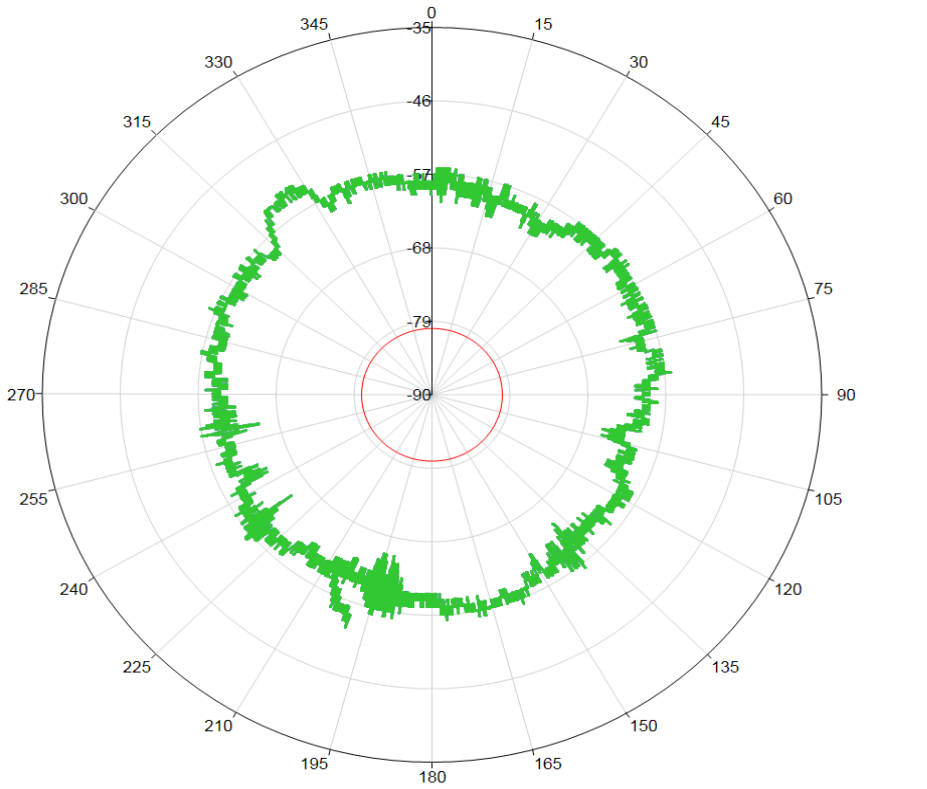
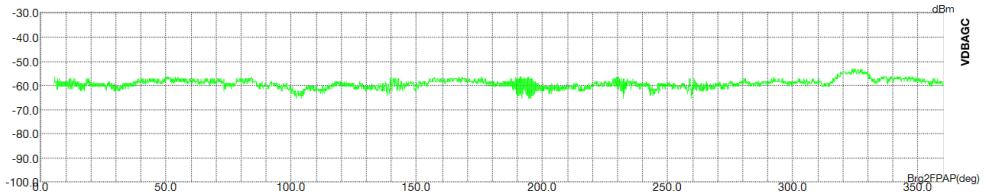
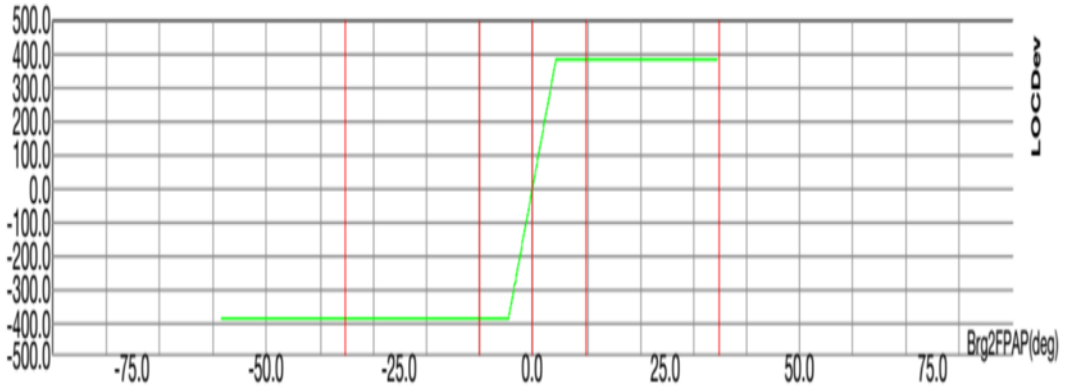




Orbit flight real-time curve

04 Conclusion and Data Analysis



Inspection

Status	Inspection	ID	01	
Commission	No	Note	20nm W	
Standard	ICAO	Initial	No	
Type	LAAS	Final	No	
Profile	CrossOver	StartAng	-58.26	deg
Direction	CW	StopAng	35.74	deg

FacData

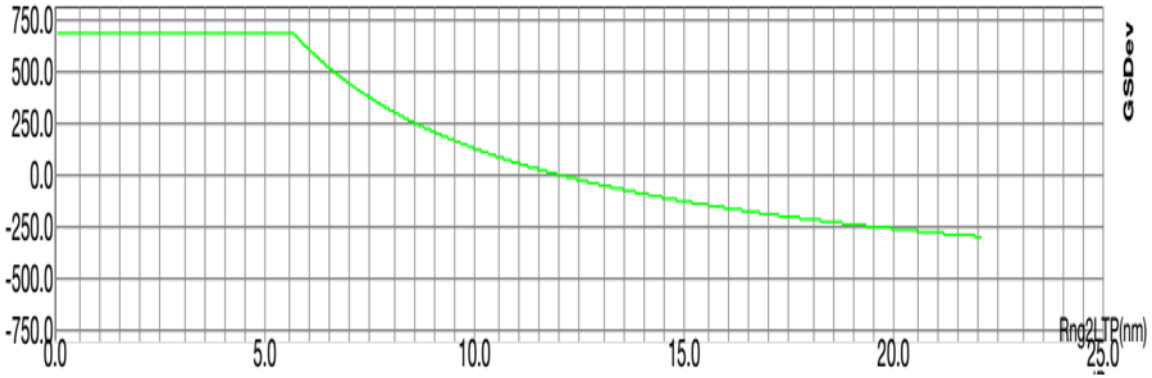
Facility ID	TJ34L
AirportID	TJWS
Runway	34L
Channel	20761

VDB AGC

MinAGC	-86.00	dBm
MinAGC	1.02	uV
Bearing	44.51	nm

Inspection

LOC Width	3.43	deg
LOC Symmetry	49.98	deg



Inspection

Status	Inspection	ID	02	
Commission	No	Note	3000 W	
Standard	ICAO	Initial	No	
Type	LAAS	Final	No	
Profile	Level run	StartRng	22.12	nm
Direction	Inbound	StopRng	-0.22	nm

FacData

Facility ID	TJ34L
AirportID	TJWS
Runway	34L
Channel	20761

VDB AGC

MinAGC	-87.00	dBm
MinAGC	10.00	uV
RngToLTP	20.91	nm

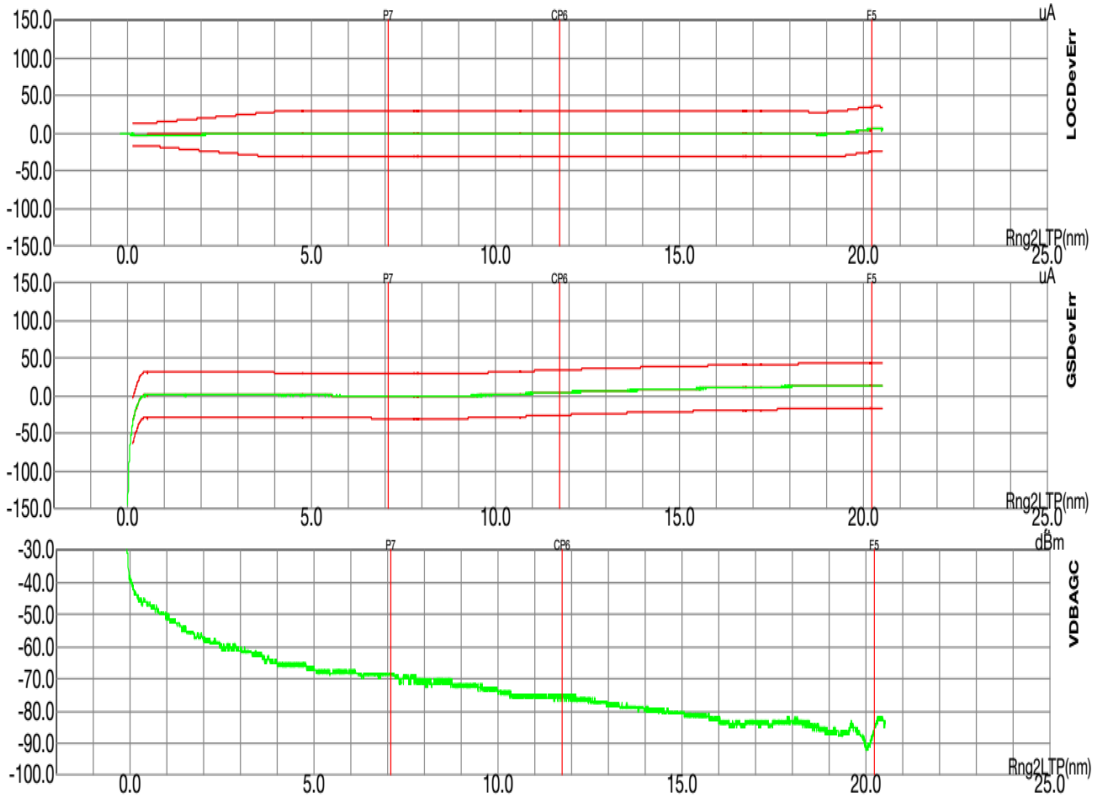
Inspection

GS Width	0.75	deg
GS Symmetry	49.99	%

Arc flight real-time curve and results

LEVEL RUN flight real-time curve and results

04 Conclusion and Data Analysis



Inspection

Status	Inspection	ID	05
Commission	No	Note	20nmAPP
Standard	ICAO	Initial	No
Type	LAAS	Final	No
Profile	Approach	StartRng	20.54 nm
Direction	Center	StopRng	-0.17 nm

FacData

Facility ID		MinAGC	-92.00	dBm
AirportID		MinAGC	5.62	uV
Runway	34L	RngToTH	20.07	nm
Channel	20761			

Localizer Result

				deg	uA	Structure	RngToTH	Polarization		Left	Right	
Angle75L	-	deg	LOCAlign	0.00	0.47	Zone1	0.50	20.27	Change	-	-	uA
Angle75R	-	deg	AbovePath	-	-	Zone2	1.10	3.16	Roll	-	-	deg
1/2Width	-	deg	BelowPath	-	-	Zone3	0.71	0.16	RngToTH	-	-	nm

Glide Slope Result

						Structure		BFSL		Zone2	Zone3	
TCH	16.96	m					DevErr	RngToTH	Angle	2.99	2.94	deg
Angle75A	-	deg	-		deg	Zone1	1.82	14.27	TCH	16.78	17.39	m
Angle75B	-	deg	OnCource	3.00	deg	Zone2	6.21	0.57	ITCP	282.53	315.17	m
Mean Width	-	deg	LeftCourse	-	deg	Zone3	1.86	0.16	AimElev	-4.65	-2.97	m

Sats Data

Sata Num Tracked	8	Sat Num	24	15	21	18	13	22	05	14
Sata Num Visible	12	Sat SNR	48	49	48	49	48	47	46	42

Approach flight real-time curve and results

04 Conclusion and Data Analysis

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卫星着陆系统飞行测试报告表

CAAC

第 1 页 共 3 页　　报告编码：GZBTJJ34L20180908

1. 机场名称	天津/滨海	2. 跑道号	34L	3. 机号	B-9301	4. 机场识别	ZBTJ	5. 日期	2018. 09. 08
6. 校飞种类	投产		定期		特殊	✓	7. 频率	116.75M	8. 波道号	20350	9. 状态	正常

10. FAS 数据飞行校验结果

参数	校验显示	校验结果	参数	校验显示	校验结果
台站识别	ZBTJ	正确	LTP 点高度（m）	-4.4	正确
跑道号	34L	正确	频率（M）	116.75	正确
下滑角（°）	3.00	正确	入口高度（m）	15.0	正确
LTP 点经度（°）	N 39-06-41.0688	正确	FPAP 点经度（°）	N 39-08-14.3124	正确
LTP 点纬度（°）	E 117-21-14.8680	正确	FPAP 点纬度（°）	E 117-20-17.6496	正确

11.VDB 信号飞行校验结果

圆周飞行 1	高度 m	1500	半径	20nm	角度°	261.98	VDB 最小信号强度 dBm/dBW/M²	-79.3/-90.41
圆周飞行 2	高度 m	3000	半径	20nm	角度°	267.05	VDB 最小信号强度 dBm/dBW/M²	-66.3/-77.41

12.进近飞行校验结果

开始距离 15 海里

程序的一致性	一致	进近精度		满意		VDB 最小信号强度 dBm/dBW/M²		-67.3/-78.41
航向校直 °/μA	-0.00/-0.28	航向结构 μA/NM		0/15.06		1/0.61		0/0.17
下滑角/入口高度° /m	2.98/15.87	下滑结构 μA/NM		1/6.56		0/0.57		5/0.15
可见卫星数量	12			可用卫星数量		9		
可用卫星编号	11	18	28	30	07	08	17	22	03		
信噪比	46	48	47	50	51	45	50	49	45		

开始距离 10 海里

程序的一致性	一致	进近精度		满意		VDB 最小信号强度 dBm/dBW/M²		-52.3/-63.41
航向校直 °/μA	-0.00/-0.27	航向结构 μA/NM		1/12.21		0/0.58		0/0.23
下滑角/入口高度° /m	2.99/15.28	下滑结构 μA/NM		1/6.55		0/0.58		3/0.16
可见卫星数量	12			可用卫星数量		10		
可用卫星编号	01	11	28	18	30	07	17	22	08	03	
信噪比	50	47	48	49	49	49	48	49	46	48	

开始距离 20 海里

程序的一致性	一致	进近精度		满意		VDB 最小信号强度 dBm/dBW/M²		-52.3/-63.41
航向校直 °/μA	0.01/0.64	航向结构 μA/NM		0/20.33		0/1.22		0/0.17
下滑角/入口高度° /m	3.01/17.4	下滑结构 μA/NM		1/6.62		1/0.57		4/0.16
可见卫星数量	12			可用卫星数量		9		
可用卫星编号	18	07	08	01	30	28	27	10	16		
信噪比	49	49	50	48	50	47	47	47	46		

卫星着陆系统飞行测试报告表

CAAC

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13.水平飞行校验结果

距离 NM	15/-2.5	高度 m	600	宽度及对称性° /%	0.75/50.02	VDB 最小信号强度 dBm/dBW/M²	-65.3/-76.41
距离 NM	15/-2.5	高度 m	900	宽度及对称性° /%	0.75/50.04	VDB 最小信号强度 dBm/dBW/M²	-63.3/-74.41
距离 NM	15/-2.5	高度 m	1200	宽度及对称性° /%	0.75/50.06	VDB 最小信号强度 dBm/dBW/M²	-60.3/-71.41

14.圆弧飞行校验结果

半径/高度 NM/m	20/600	角度°	±35	宽度及对称性° /%	3.41/50.24	VDB 最小信号强度 dBm/dBW/M²	-83.3/-94.41
半径/高度 NM/m	15/600	角度°	±35	宽度及对称性° /%	3.43/50.17	VDB 最小信号强度 dBm/dBW/M²	-85.3/-96.41

卫星着陆系统飞行测试报告表

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15.电磁环境情况	良 好

16.校验结论：

符合《"GBAS 地面设备-I 类精密进近"的天津机场飞行校验方案》中给定的容限要求。

17.备注：

1、本次为对安装在天津机场的二十所 GBAS 地面设备进行合格审定而进行的飞行测试（第一次）。

2、本次飞行测试的方法依据来源于二十所出具的《"GBAS 地面设备-I 类精密进近"的天津机场飞行校验方案》。

3、本次飞行测试的标准依据来源于二十所出具的《"GBAS 地面设备-I 类精密进近"的天津机场飞行校验方案》。

4、机长建议：GBAS 机载系统中应增加距离指示功能。

机长签字		飞行校验员签字	

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- Conduct flight inspection for more than **250** airports in China.
- **10,000** flight hours each year.
- IEC/ISO 17025 certification.
- **21** flight inspection aircrafts:1 King Air 350, 5 Citation XLS, 11 Citation XLS+, 3 Citation Sovereign and 1 G450.
- ILS, VOR/DME, NDB, SSR/PSR, PAPI, VHF, PBN(RNP&RNAV), ADS-B, RFI, HUD,GBAS, VDL-2……


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