Academic Journal of Engineering and Technology Science
ISSN 2616-5767 Vol.6, Issue 10: 63-66, DOI: 10.25236/AJETS.2023.061008

The necessity of flight calibration temperature correction of high plateau airport instrument landing system

Sun Yichi, Zhu Wenshan, Pucuo Wende

Western Airport Group Qinghai Airport Co., Ltd., Xining City, Qinghai Province, 810001, China

Abstract: *All airports in Qinghai Province are high plateau airports except Xining Airport, with an altitude of 3950 meters in Yushu Airport, 3787 meters in Guoluo Airport, 3163 meters in Qilian Airport, 2842 meters in Golmud Airport, 2862 meters in Delingha Airport and 2906 meters in Huatugou Airport. The airport for geographical environment, the temperature difference in the year round, in November, December, January, February, easy to appear extreme low temperature, and Germany, Yushu, luo, qilian airport every year in winter and summer, flight check, therefore, this paper to check in different seasons is affected by extreme temperature, flight altitude of instrument landing system calibration results difference are discussed, and puts forward the solution.*

Keywords: *high plateau airport; flight calibration; instrument landing system*

1. Introduction

The instrument landing system is mainly guided by two radio signals transmitted by the ground to achieve the course and glide path, establish a virtual path from the runway to the air, and the aircraft determines its relative position with the path through the on-board receiving equipment, so that the aircraft flies to the runway in the correct direction and smoothly descends the altitude, and finally achieves a safe landing. Flight verification mainly checks the spatial signal quality of navigation equipment, but for plateau airport flight, temperature has a certain impact on equipment parameters, for special extreme weather, through formula calculation, chart temperature correction, to achieve standard flight altitude, measure accurate navigation equipment parameter information.

2. The influence of flight altitude on flight calibration

Flight calibration means to ensure the safety of flight, using flight calibration aircraft equipped with special calibration equipment, in accordance with the relevant specifications of the flight calibration, inspection and evaluation of all kinds of navigation, radar, communication equipment and tolerance of space signal quality and flight procedures into the airport, and the report according to the results of the inspection and evaluation. There are 8 subjects for the flight calibration of the instrument landing system as shown in Table 1. According to the flight requirements of each subject, the flight altitude is summarized as shown in Table 2.

Table 1 Flight calibration course of the instrument landing system[1]

order number	equipment		Flight mode	fix a date	go into operation	Subject content (for production subject)
Subject 1	LOC TX1 GP TX1	LOC TX2 GP TX2	approach	1	1	Heading: identification, adjustment system and, straightening, channel structure, polarization Drop: adjust the system and, slide Angle, entrance height, slide structure
Subject 2	GP TX1	GP TX2	horizontal	3	4	Down the normal width, wide alarm, narrow alarm, return to normal
Subject 1	GP TX1	GP TX2	approach	1	1	Lower angle alarm

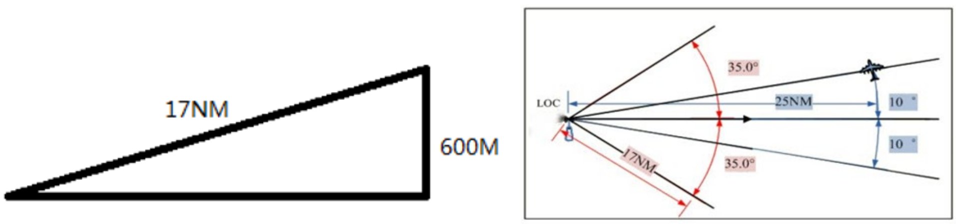
ISSN 2616-5767 Vol.6, Issue 10: 63-66, DOI: 10.25236/AJETS.2023.061008

	LOC TX1 GP TX1	LOC TX2 GP TX2	approach	1	1	Heading: identification, adjustment system and, straightening, channel structure, polarization Drop: adjust the system and, slide Angle, entrance height, slide structure
	GP TX1	GP TX2	approach	2	2	Average width of decline
	LOC TX1	LOC TX2	approach	0	2	The average width of the channel
Subject 3	LOC TX1	LOC TX2	arc	4	4	Normal heading width, wide warning, narrow alarm, return to normal
Subject 4	LOC TX1	LOC TX2	arc	1	2	Course gap, high angle gap
Subject 5	LOC TX1	LOC TX2	arc	1	2	The heading direction covered 17 NM and covered 25 NM
Subject 6	GP TX1	GP TX2	horizontal	1	1	Slide gap
Subject 7	GP TX1	GP TX2	horizontal	4	4	Falling coverage
Subject 8	LOC TX1	LOC TX2	The track center line	1	1	Directing to the police

Table 2 Flight altitude required for each subject

subject	flight altitude
Subject 1	Starting IF height, approach according to the ILS approach procedure
Subject 2	Field height is 1,200 m
Subject 3	Field height is 600 ± 150 m
Subject 4	The field height is 600 meters
Subject 5	Minimum coverage height (the highest for all three) 1. Entrance height + 600 m 2. The highest obstacle in the middle and finally approached is + 300 meters 3. ILS drops the interception height
Subject 6	450 Meters
Subject 7	The ILS drops to intercept the height
Subject 8	Runway ground

We take heading coverage as an example. According to the summary, we know that the detection instrument landing system (ILS) coverage in the calibration flight is at least 600 meters higher than the elevation of the field. According to *The Part 1 of Aviation Radio Navigation Devices: Instrument Landing System (ILS) Technical Requirements*, the signal standard of the standard service area is not less than 40 μ V / M, while according to the 8071 document and flight calibration rules, the signal strength of the heading standard service area is not less than 5 μ V (-93 dBm). When the aircraft is at 17 NM and the field height is 600 meters, the Angle between the aircraft and the heading antenna array can be calculated, as shown in Figure 1.[2]



Arcsine (600 / 31506) = 1.09°

Figure 1 Angle calculation between aircraft and heading antenna array

According to the principle of the instrument landing system, we know that when the Angle is lower, the lower the flight altitude, the lower the signal intensity. Therefore, when the actual flight altitude is

ISSN 2616-5767 Vol.6, Issue 10: 63-66, DOI: 10.25236/AJETS.2023.061008

below the standard flight altitude, the measured signal intensity of the calibration aircraft is likely to be below-93 dBm, resulting in the heading coverage limit.

3. Temperature deviation in the flight calibration results in the flight altitude deviation

We know that the main altimeter used on the plane is the atmospheric pressure height, and the scale of the atmospheric pressure height is based on the standard atmospheric pressure system, but in real life, it is basically impossible to meet the standard atmospheric pressure conditions, and there will always be various deviations. At the same time, we know that temperature will affect the relationship between the pressure height and the real height. Simply stated, it is said that high temperature makes the pressure height less than true high, otherwise, low temperature makes the pressure height higher than true high.According to the temperature correction formula (formula (1)) provided in The latest version of *Standards for Design of Visual and Instrument Flight Procedures for Aircraft Operation* issued by Civil Aviation Administration on May 19,2020:[3]

$$\Delta h = (-\Delta TSTD / L0) \cdot \ln \quad [1 + L0 \cdot hFAP / (T0 + L0 \cdot hTHR)] \qquad (1)$$

In formula: Δ TSTD——Temperature deviation of the standard daytime (ISA) temperature;

L0——The standard decreasing rate of air pressure height in the first layer of ISA (from sea level to the top of the troposphere) (-0.006 ° / m);

hFAP——The program high at the FAP above the entrance;

T0——The standard temperature at sea level (288.15 K);

hTHR——Inlet elevation above mean sea level.

We can calculate the height difference that needs to be revised at different temperatures and elevtitudes in each airport. For example, we take Delingha airport as an example to calculate the flight altitude deviation values at different temperatures in winter and summer.

It is known that the altitude of Delingha airport is 2862 m, the flight altitude of subject 5 is 3600 m, the height difference is 738 m, the low temperature is-25 ℃ in winter, and the high temperature is 30 ℃ in summer, namely Δ TSTD1= - 25 - 0.0065 * 738 = -29.797 ℃ , Δ TSTD2= 30 - 0.0065 * 738 = 25.203 ℃ .After introducing formula (1), the highest summer high altitude is 92.8 meters, and 59.1 meters low in winter. The height difference between the two flights in the same subject is nearly 150 meters, which has a great impact on the intensity of heading and slide signal. It is worth noting that this is only the use of a constant "deviation standard" temperature decline rate, and the actual decline rate is related to the latitude and the time of each year. According to the operation characteristics of high plateau airports, this algorithm compensation is relatively conservative. Moreover, when the temperature compensation is not calculated, the flight height may directly affect the height of the intercepted slide (as shown in Figure 2).

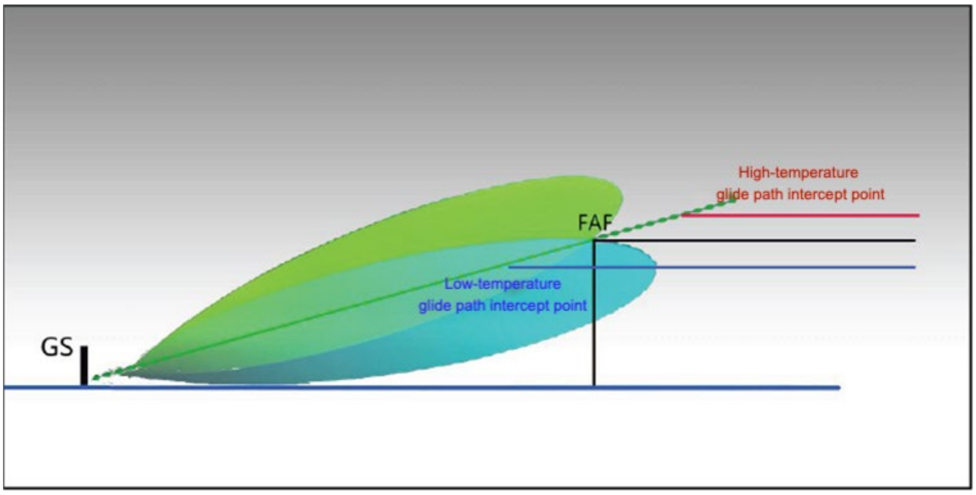


Figure 2 The Light of the slide intercept

According to the flight method of subject 2, the change of the height of the plane will affect the data accuracy of the slide width, warning and symmetry. The schematic diagram of subject 2 flight is shown

ISSN 2616-5767 Vol.6, Issue 10: 63-66, DOI: 10.25236/AJETS.2023.061008

in Figure 3.

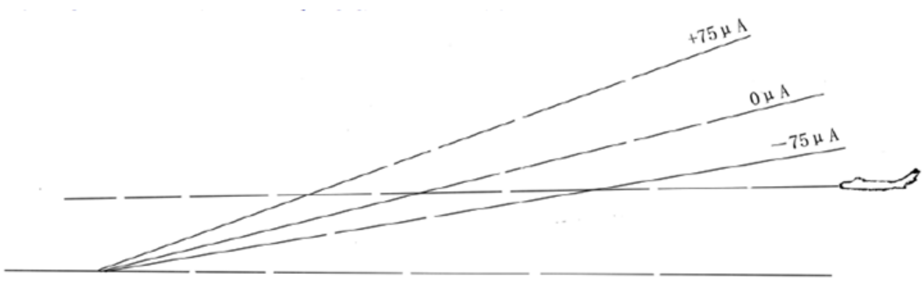


Figure 3 Schematic diagram of ILS flight 2

4. The necessity of a temperature correction

We know that the purpose of flight calibration is to accurately know the performance of ground navigation equipment, and to correct the equipment alarm threshold to strengthen the flight safety of aircraft. When the standard of flight calibration is no longer the standard, then the data obtained by the calibration flight will be meaningless, leading to the possibility of unsafe incidents. Therefore, when flying at the high altitude airport, it is necessary to correct the temperature for the special extreme weather to reach the standard flight altitude and measure the accurate navigation equipment parameter information.

At present, the commonly used means are divided into formula calculation and chart correction. Formula calculation is to use formula (1) for accurate calculation, although complex, but the calculated value is more accurate. The revised calculation is based on the non-standard atmosphere set out in the Engineering Science data Unit publication, Performance, Volume 2, No.770221. Another method is to correct through charts. Currently, the Civil Aviation Administration of China’s advisory circular “Design Specifications for Visual and Instrument Flight Procedures for Aircraft Operations” has included six charts to quickly query relevant information. However, for high altitude airports, there are no Suitable content, the highest altitude of the airport involved is only 1,800 meters, which has no practical significance for Qinghai regional airports with an average altitude of more than 3,000 meters. Therefore, it is recommended that the guidance personnel of each airport formulate a temperature revision icon based on the altitude of the field and the common flight altitude of the subject, and provide it to the school aircraft team to meet the navigation flight calibration standards.

5. Conclusions

In a word, the precision approach of high plateau airport is a very important stage, which is self-evident for the safety of aircraft operation. If the flight calibration accuracy of the Instrument landing system is not enough to send the correct signal to the aircraft, it is a loss worth the gain. Therefore, this article can warn the flight calibration crew and the navigation operation and maintenance personnel at high altitude that it is necessary for Instrument landing system to correct the temperature at high altitude airport, and it can also improve the efficiency of flight calibration and complete the flight calibration task better and faster.

References

[1] ICAO DOC 8071 File [S]
[2] The Part 1 of Aviation Radio Navigation Devices: Instrument Landing System (ILS) Technical Requirements [S]
[3] Specification for Visual and Instrument Flight Procedures for Aircraft Operation[S] AC-97-FS-005