Flight Inspection for High Elevation Airports

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ABSTRACT

As the unique civil aviation flight inspection organization of China, Flight Inspection Center of CAAC（CFI）has to face very difficult flight inspection for high elevation airports in China against complicated terrain and fluky weather. This paper introduces how CAAC CFI ensures the inspection quality based on safe flight during flight inspection in high elevation areas.

BACKGROUND

It is well-known that the southwest region of China has the highest plateau and the most complicated geographic environment in the world. With the China's booming economy, the airports construction in this region has also seen rapid development. During recent years, as the unique flight inspection organization of China's civil aviation, we are faced with challenges from lots of extremely difficult commissioning flight inspections as well as period flight inspections followed in these airports. Therefore, we have concentrated on aircraft performance, system capability study. Besides, we also focus on how to optimize inspection methods and procedures, to find out a group of practicable solutions to ensure the quality of flight inspection upon flight safety. We hope to share with you our experience in this regard, and meanwhile to exchange with professionals and experts of all institutions and countries.

AIRCRAFT AND SYSTEM REQUIREMENTS

The aircraft requirements should be extremely high for high elevation inspection flights. Beyond doubt, jet aircraft should be used for the airports whose elevation is above 10,000ft.

The following performance of the aircrafts should be considered when new aircrafts are to be introduced into the fleet to make sure they are suitable for high elevation and complicated airports missions:

-take-off and landing performance
-aircraft performance when one engine failed
-range
-airspeed
- maneuverability
-flight cost

Flight inspection system performance is also very important for high elevation airports inspection missions. The key parameters include:

-Positioning estimation method
-System processing and calculation speed
-Integration grade

Differential GPS, an advanced system with superb accuracy, efficiency and handiness, has been equipped as our current positioning systems. These systems are provided with powerful capabilities including RNAV/RNP inspection, RFI airborne DF and spectrum analysis, together with the regular inspection capabilities. Its smaller size saves a lot of cabin space and its less-than-200lbs weight saves more fuel and longer flight available.

Meanwhile, holding flight waiting for camera video process is no longer necessary after the camera updating system was replaced by DGPS.

INSPECTION FLIGHT METHOD CONSIDERATION

Flight inspection profiles at high elevation airports should be designed with very careful consideration.

-ILS-1

It is known that the first purpose of ILS-1 is to check LOC course width and symmetry at some suitable position instead of offset approach. So no matter from which location, the exact similar results with offsets is needed. Normally the distance will be about 6-11nm from the LOC antenna.

But sometimes the check position has to be changed due to the wicked terrain. Depends on different airports with different terrain, we have to adjust the flight distance to LOC and/or even the flight altitude to ensure our flight safety. Certainly, the basic requirement is to obtain the same results with half-sector offset approaches. From our experience, Localizer width is quite stable even the flight position and altitude has been changed a lot.

Another purpose of ILS-1 is to check the coverage and clearance of LOC course and this is one of the biggest problems we met at the high elevation airports. This item requires to be checked at very far distance from the LOC antenna at the lowest coverage altitude. But sometimes unexpected terrain at this distance will make this profile too dangerous or even impossible. There are two solutions: recommending procedure designer to adjust the flight procedure in order to increase the lowest coverage altitude or restrict the service volume if the whole flight procedure can be covered in the sectors which could be checked. Normally the service volume can be restricted by sector angle or service distance or combined restrictions of these two parameters. But basically we must ensure that the remainder service volume can fully support the flight procedure. For example:

According to ICAO standards, Localizer service volume is normally 17nm/±35Deg and 25nm/±10Deg. If there is mountain besides the approach final on the left compromising the safety of normal ILS-1 coverage check or affecting the Loc signal, the check angles have to be adjusted and restricted to a reasonable place. (See Figure 1) Sometimes, for some ILSs both angles and distance need to be restricted due to varying terrains. (See Figure 2)

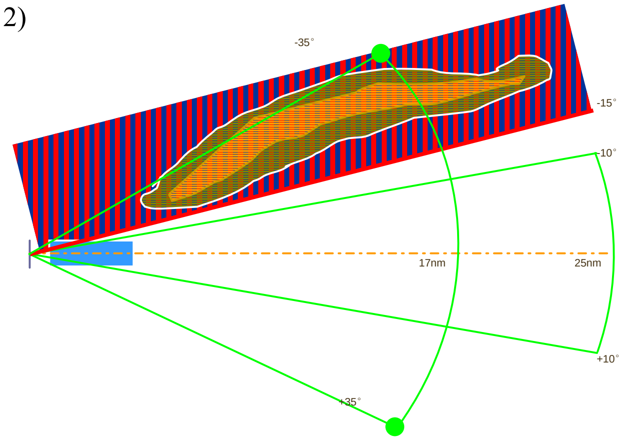

Figure 1 Angle restriction due to terrain or signal

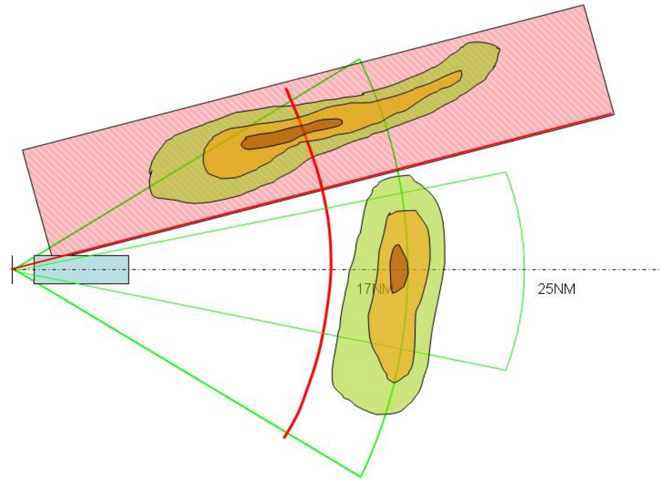

Figure 2 Angle and distance restrictions due to terrain or signal

In some cases, even we had adjusted the flight position for coverage or clearance check, one of the sampling arc ends may have to be still towards some high mountain. Facing to this situation, we usually defined the flight direction for the profile. Aircraft is designed outbound on the radial of localizer to the end of coverage arc and the sampling arc will be started from the bad terrain side. With this method we can avoid the psychological impress of dangerous even the true dangerous. (See Figure 3)

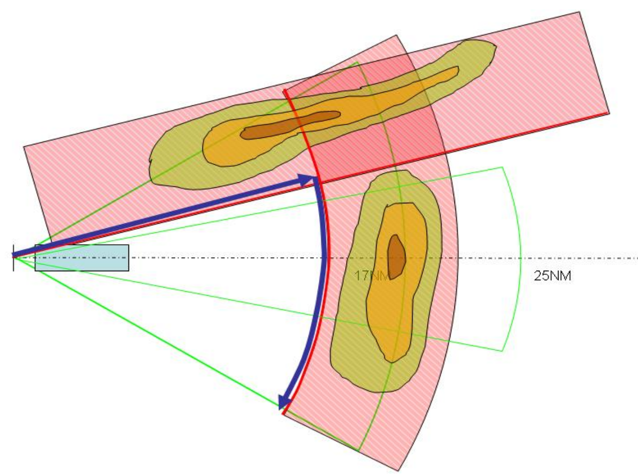

Figure 3 LOC coverage inspection flight method

-ILS-2

Similar with ILS-1, the first purpose of ILS-2 profile is to check the path width and the symmetry. In the past, we have to fly this profile at about 4000ft above the glidepath antenna elevation to decrease the angle errors caused by the uncertainies of vertical positioning. After the DGPS came into use instead of other positioning measure, we have been able to get the accurate width and symmetry at more selectable altitudes theoretically. Of course, results should be comparable with offset approach too. Then we can design inspection profile at the best altitude and sample position to obtain more reasonable results.

It is suggested by manufactory that the clearance should normally be checked at 1000ft above the glidepath antenna. But it would be very difficult or sometimes impossible at high elevation airports with complicate terrains. The only way is to raise the flight level and extend the final in order to check the angle down to 0.45θ. (See Figure 4) For some airports, 0.45θ can not be achieved due to terrain, then the glidepath will be restricted to the lowest angle which could be checked based on flight safety.(See Figure 5). In this case, -190UA should be detected to ensure the structure below path. While raising the profile, we also need to consider the far distance distortion and signal attenuation of the glidepath and achieve the best balance.(See Figure 5)

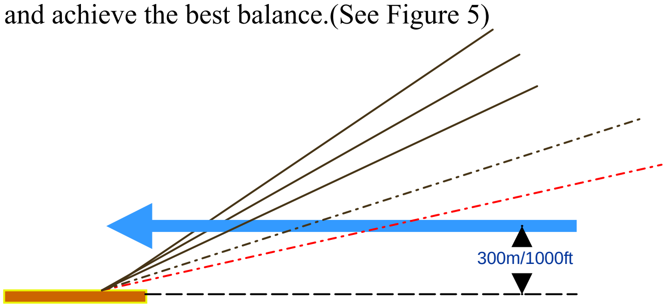

Figure 4 Normal method for glidepath clearance check

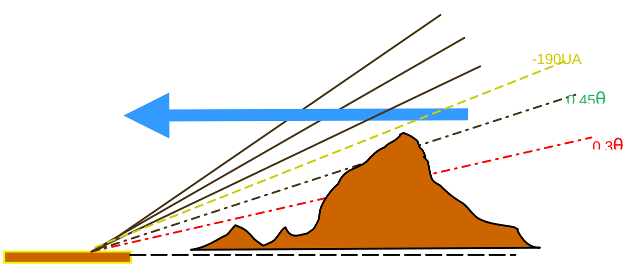

Figure 5 Clearance check at high elevation area

-Offset Approach of ILS-3

Offset approach is another difficult profile for high elevation airports with complicate terrains since the integrated cockpit instruments of our new jet cannot coupled with offset unit. Normally the approach final is selected along the best clearance direction during the airport design, but the obstructions beside the final approach protection sector edges may be steep. It may imperil the flight safety if aircraft swings too much during interception of 75UA offset line of the localizer course as the aircraft speed is normally much higher at high elevation area. A solution could be got based on GPS by developing a quasi-RNAV procedure for this profile. An offset extended line can be easily defined by calculating some points coordinates before point A if we know the exact LOC antenna position, accurate course bearing and course width. These points will be input into FMS and keep the aircraft intercept this line by autopilots. The flight will then be easier and more stable to avoid approaching the obstructions near by offset line. The normal GPS horizontal error is normally within 6 meters, and FMS coordinate input precision is of 0.01 seconds, which could cause a vector error of 0.007nm (13m) in maximum. From calculation, the total error could reach 19m which equals to about 0.07 degrees or 7 UA at 8nm from Localizer antenna and 0.10 degrees or 9 UA at point A for a localizer which course width is of 3.24 degrees(As the airport runway in high elevation areas is usually quite long)(See Figure 6).

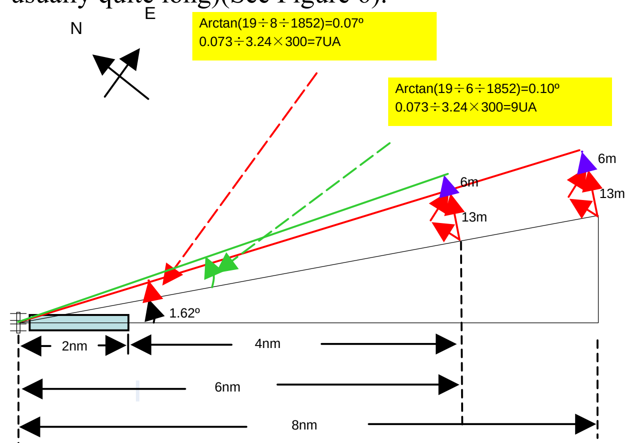

Figure 6 Position errors calculation

When aircraft passed point A, the same distance position error will turn larger in degrees and UA and make aircraft deviating too far from 75UA offset line and affect the facticity of the results. For example, the same distance error equals to 0.20 degrees and can cause a deviation of 18UA from offset line at the point 3nm from LOC. So the quasi-RNAV method is only used before point A to assist pilot intercept 75UA line, and then be replaced by manually track. (See Figure 7)

ILS-1 is usually flied instead of offset approach during periodic inspections after the set-up of results correlation between ILS-1 and ILS-3 and shows comparable in order to save flight time and decrease flight difficulty.

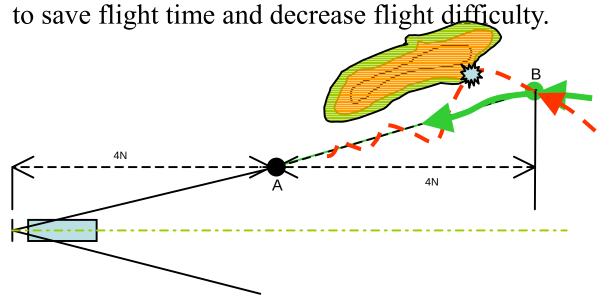

Figure 7 Offset flight method

VOR/DME orbit and radials

Some VOR/DMEs are located at valleys where signals can be received well only along the flight procedures which are above the valley. The restriction sectors can be defined during the commissioning inspection and the best bearing and segment will be chosen to be reference radial. When the VOR/DME orbit is checked, some small orbits can be flied instead of the whole orbit at the mountain cols (See Figure 7) for periodic inspections in order to save time.

Short-term VOR signals roughness can be more than 3 degrees during some en-route radial checks. In most cases, they are caused by multi-path reflections and the signals can not be ameliorated due to this insurmountable factor. If the roughness which is more than 3 degrees lasts a distance less than 0.25nm within each 5nm segment, we will not restrict the roughness segment, because it won't affect the safety for en-route flight.

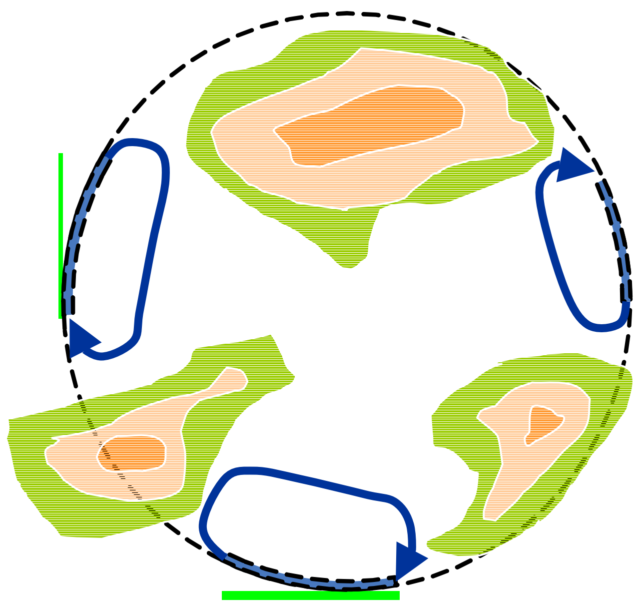

Figure 7 VOR/DME Orbit check at high elevation area

-Inspection flight procedures manual

A serials of manuals were constituted by CAAC CFI to define all the inspection flight profiles for each airport especially the high elevation airport in order to keep all the inspection crew fly on the same path. We can benefit a lot from this effort by getting comparable inspection results, ensuring inspection quality and flight safety.

High altitude profiles are normally drawn on the background of flight chart to show the relationship between profile paths and normal flight procedures, while low altitude profiles are drawn based on terrain map to show pilots the geographic environment around flight paths.

Environment changes around airport could be caused by new obstructions such as buildings or trees which may compromise flight path safety or inspection results. So most of our inspection flights are based on VMC and need very careful preparation. According to regulations of our manuals management, crews may adjust the flight procedure position and issue new restrictions upon the actual environment and inspected signal status. Feed back should be provided to manuals management office to report any change of the procedure together with the considerations or reasons. Then an update of the manual will be made for next inspection of that airport. With this circle, we can renew our information to ensure flight safety and inspection quality in best efforts.

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3. *UNITED STATES STANDARD FLIGHT INSPECTION MANUAL, FAA Order 8200.1*

Biography of Pan Yi and Liu Tong

Biography of Pan Yi

Mr. Pan Yi graduated from Civil Aviation Flight University of China and became a flight instructor in 1971. He used to hold pilot licenses of more than 25 types of aircrafts including Boeing 777, Tu-154, Y-7, Citation X, etc, and is one of the most experienced pilot in China Civil Aviation. He had been the following headships from 1992 to 2002:

Deputy Manager of China Changcheng Airlines

Deputy Director of Tech Inspection Division of Flight Standard Department of CAAC

Director of Operation Supervision Division of Flight Standard Department of CAAC

In 2002, he took up the post of the Director of Flight Inspection Center of CAAC.

Biography of Liu Tong

Mr. Liu Tong graduated from Civil Aviation University of China and became a radar maintenance in 1989. After 3 years work experience and passed knowledge exam, he was chosen to join the flight inspection team of CAAC Flight Inspection Center and became a flight inspector. Now, he holds the post Deputy Director of Safety and Tech Department of Flight Inspection Center of CAAC.