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LOCATION OF ILS SCATTERERS

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ABSTRACT

Specular reflection from the wall of a building outside the airstrip area caused unwanted interference to the ILS system although the building is some 600 metres away in the back sector of the glide-path antenna. The glide-path installation is much more vulnerable to scatter interference than the narrow-beam localiser because it must have a horizontally broad beam in order to cover the whole approach path from a site off the centreline. The antenna also radiates a great deal into its back sector. At Schiphol the 36R runway had scatter problems in the glide path because the inclination of a 14m high and some 170m long glass and metal wall of a new building reflected the back radiation just to the approach path. The source of the interference, i.e. the mirror image of the glide-path antenna, was located with ILSmapper program that can paint a map from inspection flight data. The trouble was alleviated with improved antenna reflectors. Simultaneous localiser data together with the glide-path approach recording was of vital importance in solving the case. Of equal importance are also correct points of reference and several parameter values.

HISTORY

ILSmapper program has been available since begin of 2001. An improved version of it is two years old already. The program paints a map of ILS scatterers from inspection flight data.

Already in the autumn of 2001 I received from the Netherlands an inquiry on ways to widen the view of the map sidewise. My conclusion was that a scatterer beyond some 600m from the centreline would hardly disturb a modern ILS unless it is a long metal wall and only in the glide path (GP) case. The wave train caused would also be several kilometres long and would perhaps require unreasonably much more memory for the program.

18.11.2003 a request for help arrived from Schipol: the GP of the 36R runway had a disturbance due to a non-located scatterer. The magnitude of the interference was not big but because of its frequency it spoiled the monotonous change of the GP reading in curved approach to the centreline. The inquiry in 2001 came again into my mind.

Soon two sets of inspection flight data arrived, modified for ILSmapper input. The result was a surprisingly smeared map although the nicely oscillating interference hinted to a point scatterer.

Three months later further flight data arrived. The map converged to a point some 600m from the centreline and about 600m behind the antenna, if the localiser width was halved. Geographic maps available indicated nothing there.

Soon thereafter I received an up-to-date map of the area. There was a big building behind the GP antenna. Its metal and glass wall, some 170m long and about 14m high, reflected the back radiation from the GP antenna exactly in the direction of arriving aeroplanes. It created a point-like mirror image of the antenna.

The fact that the mirror image landed somewhat outside the display area of the ILSmapper prompted immediately the design of an addition to the program, namely the sideways shift of the map without big additional memory requirement, along with some other improvements.

ANALYSIS

Several questions remained still open. Why should the localiser width be halved? Why was the wall aligned as it was? Why an up-to-date geographic map (Figure 1) was not immediately available?

The input requirements and the working principle of the ILSmapper have been explained at length in my paper presented four years ago[1]. In short, the influence of the somewhat meandering lateral flight track of the aeroplane has to be corrected in two steps. First the theodolite data is subtracted from the receiver output. Then this result is fed into the ILSmapper with the theodolite data in the localiser case and with the recorded ILS localiser output in the GP case (in order to save another theodolite). Because the localiser is at the stop end of the runway the far away from the GP site, distance between localiser and GP antennas is an important parameter in calculation of the lateral track in the GP case. The distance to aeroplane is measured from the antenna under study, e.g. from the GP antenna in this case.

The inspection flight team prepared the input data, the construction section took care of building tasks and maps and the ILSmapper was in custody of the ILS engineer.

Instead of the localiser receiver data the inspection flight team prepared synthetic data that was unfortunately based at the approach end of the runway. Adding the distance between localiser and GP antennas roughly doubled the lateral deviations of the aeroplane from the centreline in the distance area of interest. Therefore halving the localiser width produced a nearly accurate result. A small value of the distance between antennas gave a correct result with true localiser width. Most difficulties so far have arisen just from input errors, i.e. ignorance of the advice existing in Help|File.

The reflecting wall (Figure 2) of the building had been erected with nice architecture in mind. It was aligned with the centreline of a crossing runway. Had it been aligned otherwise the back radiation of the antenna would have pointed to a harmless sector.

Missing up-to-date maps mislead the analysis at the outset. The engineer responsible of radio navigation aids simply received them from the construction sector with some delay.

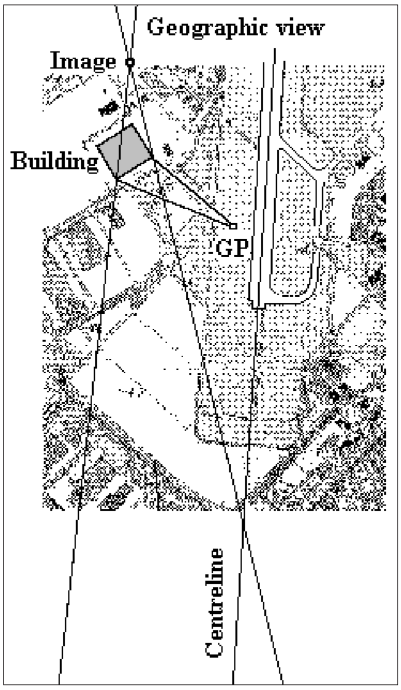

Figure 1. Geographic view

Figure 2. View towards the reflecting wall

CURE

The outcome of the analysis was immediately verified with the aid of makeshift additional antenna reflectors. The time of construction of the building coincided with the onset of the interference, too.

Provision of the antenna mast with improved reflectors lasted some months. Announcing the amendment of the ILS to higher category understandably required unequivocal location of the scatterer, the description of the improvements made and new inspection flight data. The mirror image of the GP antenna (Figure 3) located by ILSmapper was not the least important item here. It was a hard copy of something you cannot see otherwise. Flight tests confirmed the improvement achieved with additional reflectors (Figure 4).

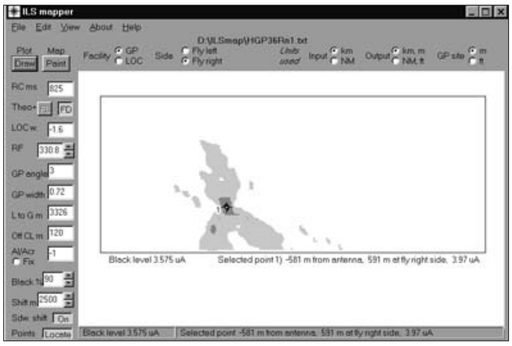

Figure 3. ILSmapper view: co-ordinates of the image of GP antenna

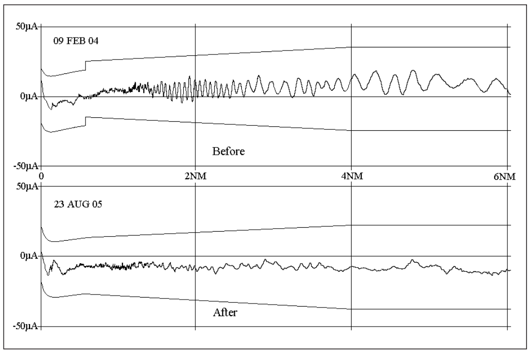

Figure 4. Typical glide path records before and after antenna modification

CONCLUSION

Difficulties in the analysis of scatter cases highlighted above can be avoided by acquiring the ILSmapper program to the inspection flight team. The Help feature of the ILSmapper advises users in detail in edition of the correct form of the input data. Non-conformity of input data has been the most frequent cause for malfunction of the program or useless results. Different practices in recording the inspection flight results seem to cause difficulties. Standardisation in this area would help.

Prevention of scatter cases like this is more complicated. New buildings are constantly erected on the airport area everywhere. Teams on very different tasks work in the same area and thumb rules (e.g. avoid areas in front of antennas) are valuable. They are not always enough, however.

I asked experts at home whether there would be a risk of similar scatter case. The answer was affirmative. Thus close co-operation between various experts is necessary. Synthesis with e.g. Axis 330 program from NANCO in the glide path case would help, too. And if something goes wrong anyway, the ILSmapper can pinpoint the scatterer and produce a hard copy for necessary technical and administrative measures.

REFERENCES

1. Touko Hahkio: Input Requirements of ILS Mapper Program. Paper presented at the 12th International Flight Inspection Symposium, Rome, June 3 - 7, 2002.