Groenenbergterrein

Safeguarding Study

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Glossary

AIP	Aeronautical Information Publication
GBT	Groenenbergterrein
GP	Glidepath (element of ILS)
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
Km	Kilometres
LLZ	Localiser (element of ILS)
LVNL	Luchtverkeersleiding Nederland
MLS	Microwave Landing System
NLR	Nationaal Lucht en Ruimtevaartlaboratorium
NM	Nautical Miles
OAS	Obstacle Assessment Surfaces
OLS	Obstacle Limitation Surfaces
θ	Theta. The nominal glidepath elevation angle

Numbers in superscript brackets [ ] refer to reference documents listed in Section 9.

NOTE: All distances and dimensions in metres unless stated otherwise.

Executive Summary

Cyrrus

Cyrrus Associates Limited is a company that provides consultation and services for Communication Navigation and Surveillance/Air Traffic Management (CNS/ATM) issues and has provided advice to a number of airport operators and Aviation Authorities on airspace matters throughout Europe since 1999. One of its core competencies is the activity known as safeguarding, which is the assessment of the effects of building developments on the technical performance of radio navigation and surveillance systems. The Company has undertaken several airport navigation systems safeguarding tasks in the UK and Ireland. Safeguarding work has been undertaken at the following major airports: Bournemouth, Blackpool, Bristol Filton, Coventry, Cranfield, Exeter, Jersey, Leeds Bradford, London Heathrow and Robin Hood – Doncaster Sheffield. Cyrrus Associates consultants have recognised qualifications in Air Traffic Control (ATC) Systems Engineering and operational experience in ATC matters. Cyrrus staff have received formal training in the use of AXIS ILS simulation software and have an excellent knowledge of ICAO Annex 10 and 14. The Company has a proven track record for conducting detailed analysis of ILS systems and presenting the findings in a concise and understandable way, working to International, European and National standards according to the regulatory requirement in the country where the task is required.

Summary of Report

Planning permission for the development of the Groenenbergterrein by Chipshol has been opposed by LVNL on the basis of interference with the Instrument Landing System Glidepath facility serving runway 36R at Amsterdam Schiphol airport. Cyrrus Associates Ltd has carried out an independent evaluation of the impact of the development on behalf of Chipshol and assessed the basis of the objections raised by LVNL.

The main findings of this investigation are:

- No firm basis has been established in terms of potential effects on Instrument Landing system performance for LVNL's objection to rezoning in 1996.
- The glidepath simulation carried out by LVNL in 1998 for areas A and B was not realistic. The conclusion that the maximum building height in area B was 0m, and in Area A 3m is not supported by the simulation evidence. The buildings proposed by Chipshol would not cause the level of ILS glidepath disturbance stated by LVNL. Detailed conclusions regarding this simulation are:
    - The only conclusion that can be reached from the LVNL simulation is that the construction of a building of the dimensions modelled (i.e. a metal clad building 300m long and 10m high, parallel to the runway and in the location stated) would lead to a disturbance of 11.21μA in Zone 3. The acceptability of this figure is subject to analysis of the existing error budget. It is not possible to determine from the data presented the acceptability or otherwise of any other building development on the Groenenbergterrein and certainly not applicable to development of areas A and B.
    - The simulation does not in any way justify any building height restrictions.

- The configuration of the simulation resulted in an exaggeration of the predicted effects.
- Technically, the results of the LVNL simulation did not exceed the remaining error budget if the simulation and existing static error budget are added by vector addition using Root Sum Squares method.
- On the evidence provided of the ILS simulation and subsequent planning objections, the conclusions and decisions made by LVNL on the Groenenbergterrein were based on a simulation that was inaccurate and unrepresentative. Furthermore, the simulation does not support the conclusions reached by LVNL.

➢ The errors made presented a false premise on which to base planning decisions.

➢ The LVNL objection to the Circle Freight building request in 1999 was based on the 1998 simulation. This simulation evidence provided was not a realistic basis for assessment of the Circle Freight facility. Independent simulation indicated negligible disturbance to the ILS. There is no evidence that construction of the Circle Freight facility would result in downgrading of the ILS category of operation.

➢ No technical evidence has been made available to substantiate the building stop placed on Chipshol for the revised building plan GBT813bl01 in 2002. Independent assessment has demonstrated that the building proposal contributed very little disturbance to the glidepath performance, well within the limits specified by LVNL.

➢ Independent evaluation has been unable to substantiate the claim made by LVNL that any of the proposed developments of the Groenenbergterrein, including truck parking, would result in downgrading of the ILS facility performance from Category III to Category I.

➢ Chipshol were not made aware of any measures by which design of the Groenenbergterrein development could be optimised to reduce any impact on Instrument Landing System performance. Had this dialog taken place, issues raised by NLR and LVNL in 2005, could have easily been resolved.

➢ It is considered that the determination of residual error budget by LVNL and NLR for the Instrument Landing System has been incorrectly applied, thereby invalidating the basis for objection to the disadvantage of the developer.

➢ The application of MLS critical and sensitive areas is considered excessive in protecting the existing operational requirement and to the disadvantage of the developer.

Chipshol Questions and Cyrrus Answers

The basis of the investigation was a series of specific questions asked by Chipshol. These questions are listed below in SMALL CAPS together with answers in *blue italics* provided by Cyrrus Associates Ltd.

1996 Rezoning advice LVNL

a. IS THE STATEMENT THAT THE APPLICABLE AREA SHOULD MAINTAIN ITS AGRICULTURAL DESIGATION IN CONNECTION WITH ILS INTERFERENCE CORRECT?

Although the area falls within the safeguarded area of the ILS glidepath serving runway 36R, this in itself is not a justification to prevent development.

b. CAN THE POSITION OF AN ILS BE MOVED?

Technically, the ILS glidepath could be relocated to the East side of the runway, although there may be very good technical and operational reasons why this would not be acceptable.

c. IS IT CORRECT TO ADVICE AGAINST REZONING OF AREA A1 BECAUSE IT IS SITUATED IN THE GLIDE PATH INTERFERENCE ZONE?

The GBT is within the safeguarded zone. This in itself is not a justification to oppose development unless it can be demonstrated that the development would have an unacceptable effect on ILS performance.

1998 Rezoning advice LVNL

d. DOES THE SIMULATION EXECUTED LEAD TO THE CONCLUSION THAT THE BUILDING HEIGHT OF AREA A AND B WAS RESTRICTED TO RESPECTIVELY 3 AND 0 METERS

The simulation does not provide any evidence in which the conclusion of maximum building heights could be based.

e. IS THE STATEMENT OF LVNL CORRECT THAT DUE TO ILS RESTRICTIONS THE MAXIMUM CONSTRUCTION HEIGHT IN AREA A IS 3 METERS AND FOR AREA B NO CONSTRUCTION AND/OR NOR PARKING PLACES ARE ALLOWED;

There are no known ILS restrictions that would incur the universal building height restrictions stated.

f. WOULD CONSTRUCTION IN AREAS A AND B IN EXCESS OF RESPECTIVELY 3 AND 0 METERS LEAD TO DECLASSIFICATION OF THE ILS FROM CAT III TO CAT I OR CAT II?

There is no evidence from the simulation that development as planned in Areas A and B would result in downgrading of the ILS facility performance category.

g. WHICH MAXIMUM CONSTRUCTION HEIGHT IS IN YOUR OPINION ACCEPTABLE IN RESPECTIVELY AREA A AND AREA B;

Subject to modelling to ensure no detrimental effect on the ILS, the maximum building heights are limited by the Obstacle Limitation Surfaces in defined ICAO Annex 14. These heights are > 20m for area B and >35m for area A. Buildings of 20m in area B and 30m in area A can be constructed at a suitable orientation to reduce effects on the ILS glidepath to an acceptable level.

h. WHICH MAXIMUM CONSTRUCTION HEIGHT IS IN YOUR OPINION ACCEPTABLE FOR THE ENTIRE GBT CONSIDERING THE THEN APPLICABLE ILS CONFIGURATION?

The maximum height for the entire GBT would be dependant on the building orientation. Buildings parallel to the runway and located towards the north eastern part of the site would be restricted to less than 3m. Careful design of the buildings would allow 9m buildings at the eastern side of the site, increasing to in excess of 20m at the western side without excessive disturbance of the ILS.

LVNL in their May 15th and July 23rd 1998 letters refer to a simulation.

i. COULD YOU RECOMPILE FROM THAT SIMULATION WHAT LVNL' S ASSUMPTIONS WERE AND

IF SO IF THOSE WERE CORRECT CONSIDERING A BEST PRACTICE EFFORT?

The 1998 ILS glidepath simulation by LVNL has been investigated and the conclusion reached that the simulation was neither worst-case nor representative. The configuration used served to exaggerate the effects on the glidepath. As such, the simulation, and the conclusions drawn from it cannot be considered best practice.

j. DID LVNL ACTUALLY MAKE A SIMULATION OF PLAN A AND B IN THIS SIMULATION? IF NOT WHAT TYPE AND ORIENTATION HAD THE BUILDING ON WHICH THE SIMULATION WAS EXECUTED. PLEASE ELABORATE ON THE CONSEQUENCE OF THE ORIENTATION OF THE SIMULATED BUILDING.

The 1998 ILS glidepath simulation by LVNL did not model areas A and B. The building simulated was a 300m long by 10m high smooth metal plate orientated parallel to the runway. This represented a worst-case rather than realistic simulation. Buildings of the orientation proposed by Chipshol have very little impact on ILS Glidepath performance compared to buildings parallel to the runway.

k. IF YOU JUDGE THE LVNL SIMULATION WHAT ARE YOUR CONCLUSIONS?

- WAS THE ASSESMENT EXECUTED IN ACCORDANCE WITH BEST PRACTICE STANDARDS? IF NOT WHY NOT.

The 1998 ILS glidepath simulation by LVNL was not representative of the design proposed by Chipshol. It would be reasonable to expect that as Chipshol had provided drawings of the development, that LVNL would assess a realistic scenario and base any response on the outcome. Had this been carried out using realistic scenarios, then it would not have substantiated objections to the 1998 rezoning plan, the 1999 Circle Freight plan, or the 2002 GBT813bl01 plan.

The incorrect calculation of remaining error budgets has resulted in conclusions been drawn and decisions made which are difficult to substantiate. As a result, objections have been made to plans that fall within the remaining error budget on a false premise.

It is not unreasonable to expect the developer to be informed of the effects of building design and layout and how these may be optimised to minimise any effects on ILS performance. The truck parking is an example where a simple design change could have removed the reason for the objection.

- IF NOT, WOULD THE RESULT HAVE BEEN MATERIALLY DIFFERENT?

A realistic appraisal of areas A and B would have revealed that even buildings much larger and higher than those proposed by Chipshol would have negligible impact on ILS Glidepath performance.

.1999 Circle Freight Building Request

l. IN ITS REJECTION OF THE SPECIFIC CIRCLE FREIGHT BUILDING REQUEST, LVNL REFERS TO THE MOTIVATION OF THE NOVEMBER 16TH 1998 LETTER. IS THIS MOTIVATION VALID?

The rejection refers to buildings within the safeguarded areas for ILS; this in itself is not a cause for rejection without a technical assessment. There is no evidence from a technical assessment that the Circle Freight facility as proposed was either modelled or found to have adverse effects in ILS performance.

Building height is only one parameter of the building that influences the effect on ILS performance. There are other parameters that can have a significantly greater effect, such as orientation, location, shape and materials used. The statement of maximum building heights is therefore considered inappropriate for ILS safeguarding.

m. WHAT IS THE TOTAL ILS HINDRANCE CAUSED BY THE CIRCLE FREIGHT PLAN?

Simulation of the Circle Freight proposal indicates that the proposed development has almost no measurable effect on ILS glidepath performance.

n. WOULD THE CONSTRUCTION OF THIS SPECIFIC PROJECT LEAD TO DEGRADATION TO CAT I OF THE ILS?

No. It is unlikely that the effects of the development would be measurable.

2002/2003 BUILDING STOP

o. DOES THE CONSTRUCTION OF AREAS I AND IV CAUSE AN ADDITONAL DISTURBANCE OF 58.7%?

Modelling carried out by Cyrrus Associates has not substantiated the claimed disturbance. Additionally, it is considered that the percentage disturbance has been calculated incorrectly by arithmetic rather than vector addition.

p. WHAT ARE THE CONSEQUENCES IF THE ENTIRE PLAN AS REFERRED TO IN THE DRAWING ARE TO BE REALISED (AREAS I, III, IV AND V)?

Construction as planned is expected to lead to some disturbance to the ILS glidepath performance but this is expected to remain within acceptable levels. The level of disturbance can be minimised further by careful planning.

q. AFTER REALISATION OF THE PLANS THE REQUIREMENTS FOR CATEGORY II AND III ARE NO LONGER COMPLIED WITH LEADING TO THE DE CLASSIFICATION TO CATEGORY I.

IS THIS STATEMENT CORRECT?

Cyrrus Associates has found no evidence to support the claim that development of the GBT would result in the downgrading of the ILS from Cat III to Cat I.

r. WOULD THE ADDITIONAL DISTURBANCE CAUSED BY EXECUTION OF CHIPSHOL'S PLAN V.2002W813B01 of **October 29th 2002** LEAD TO DE-CLASSIFICATION OF THE ILS FROM CAT-III TO CAT-II OR CAT-I?

Cyrrus Associates has found no evidence to support the claim that development of the GBT would result in the downgrading of the ILS from Cat III to Cat I.

s. WOULD THE GLIDE PATH SIGNAL NO LONGER QUALIFY TO ICAO ANNEX 10 IN RESPECT OF CAT III LANDING OPERATIONS?

There is no evidence to support the claim that development of the GBT would result in the ILS glidepath no longer supporting Cat III landing operations.

LVNL USED AXIS SOFTWARE FOR ITS ASSESMENT.

t IS IT THEN IMMINENT THAT LVNL MUST HAVE KNOWN WHAT THE CAUSE FOR THE DISTURBANCE WAS IN 2003?

The causes of disturbance by buildings and the effect of orientation, size, location and the subsequent influence on the ILS are expressly stated in LVNL letter LVB

801038 of 16th November 1998. It is therefore reasonable to assume that the issues were well known to LVNL throughout this process.

u. CONSIDERING THE GARBAGE IN GARBAGE OUT PRINCIPLE COULD YOU RECOMPILE FROM THAT SIMULATION WHAT LVNL' S ASSUMPTIONS WERE AND IF SO IF THOSE WERE CORRECT CONSIDERING A BEST PRACTICE EFFORT?

The simulation was neither realistic nor worst-case. The simulation was not configured to accurately represent the scenario, and the presentation did not make clear what the major issues were. The simulation is only valid for a particular structure, located in a precise position, and at an exact orientation. From the evidence presented, no further conclusions can be made on the effect of other structures or actual development. Inexact configuration of the simulation also led to the results presented being exaggerated.

2005 NLR REPORT

v. IS THE ILS DISTURBANCE CAUSED BY PLAN V.2002W813B01 (INCLUDING TRUCK PARKING) IN EXCESS OF THE APPLICABLE LIMITS?

Modelling and simulation carried out by Cyrrus Associates has not demonstrated that the development as planned would exceed LVNL tolerances or cause downgrading of the ILS facility performance category.

w. WAS THE REMAINING ILS HINDRANCE IN THE NLR REPORT CALCULATED CORRECTLY? IF NOT WHAT WAS THE CORRECT ILS HINDRANCE BUDGET.

It is considered that the treatment of remaining error budgets was incorrectly assessed. Of the 14.14µA total static error budget, LVNL had stated that 54.6% (7.72µA) was already used (from NLR report NLR-CR-2006-185). The remainder has been assessed by LVNL and NLR as 14.14µA - 7.72µA=6.42µA. Bends are a result of the vector addition of multipath components; it is normal practice to add vector quantities by Root Sum Squares method, not by straight arithmetic addition. In this case the remaining budget is 11.84µA not 6.42µA as stated by LVNL. The assessment of the plans submitted by Chipshol was therefore based on an erroneous assumption to the disadvantage of the developer.

x. IS DISTURBANCE CAUSED BY TRUCKS TO BE CONSIDERED AS STATIC OR DYNAMIC DISTURBANCE?

As the truck parking is variable, it raises the question as to whether this should be allocated to the static or dynamic budget. A reasonable resolution would be to allocate half of the potential disturbance to static bends and half to dynamic bends.

y. IF THE TRUCKS CAUSED EXCESS HINDRANCE WOULD THERE BE A (SIMPLE) SOLUTION TO SOLVE THIS?

The truck parking issue can be readily solved as illustrated in this report either by screening the trucks from the ILS glidepath with a suitable fence or structure, or by changing the orientation of the trucks.

VI. LIB

z IF YOU CONSIDER THE HEIGHT RESTRICTIONS UNDER THE LIB CAN YOU VALIDATE IF THOSE RESTRICTIONS ARE MANDATORY UNDER EITHER ICAO ANNEX 10 OR ANNEX 14.

The only mandatory height restrictions published by ICAO are the Obstacle Limitation Surfaces specified in Annex 14. The adoption of the Obstacle Limitation Surfaces is mandatory to ICAO member states. Other height restrictions, e.g. for safeguarded surfaces, are advisory, and not designed to prevent building development. The height restrictions quoted by LVNL do not appear to be derived from mandatory ICAO requirements.

aa DOES ICAO SET OUT ANY HEIGHT RESTRICTION IF SO IN WHAT ANNEX AND WHAT HEIGHT RESTRICTION

ICAO publishes Obstacle Limitation Surfaces for licensed aerodromes in Annex 14. These surfaces are designed to reduce the risk of aircraft collision with obstacles. The adoption of the Obstacle Limitation Surfaces is mandatory to ICAO member states.

ICAO issues guidance on safeguarding surfaces for technical facilities. These are not mandatory.

VII. General questions:

ab CONSIDERING THE ENTIRE OUTCOME AND THE CONDUCT OF LVNL FROM 1996 TO 2005 WOULD YOU CONSIDER LVNL' S CONDUCT A BEST PRACTICE CONDUCT;

From the evidence presented by Chipshol, LVNL has at best been over zealous in safeguarding the performance of the technical facilities that it is responsible for, and at worst been negligent in basing responses to planning applications on unrealistic scenarios and inaccurate assessments of data. Our conclusion is that the process cannot be considered best practice conduct.

ac DETERMINE THE LOCATION AND HEIGHT OF FUTURE DEVELOPMENTS OF AVAILABLE REAL-ESTATE ON GBT INCLUDING TRUCKPARKING. DETERMINE AREA WHERE NO DEVELOPMENTS CAN BE CONDUCTED

With careful design of buildings and layout, there should be little restriction on development of the GBT. The only area of the GBT where development could be restricted is within the Public Safety Zone area, although it is noted that the development to the west, opposite the GBT has been built in such an area.

Conclusion

The statements by LNVL from 1996 to 2003, that the Chipshol building plans or that any development of the Groenenbergterrein would have very serious effects on ILS, in the sense that these building plans would result in downgrading of the ILS category of operation from III to I thereby restricting aircraft operations at Schiphol airport, could not be substantiated by any technical evidence.

The technical models used by LVNL, and the interpretation of the simulation results did not support the conclusions reached by LVNL.

It is evident that there has been a lack of transparency of the process by which objections have been made to the Groenenbergterrein development. As an Air Navigation Service Provider, LVNL is required to safeguard the performance of its navigation facilities. Nonetheless, planning objections without a realistic technical evaluation of the impact of such development cannot be considered best practice and is not in accordance with accepted international guidelines.

1 Introduction

1.1 General

1.1.1 This document describes the work undertaken by Cyrrus Associates Ltd in addressing the Statement of Work provided by Chipshol. The statement of work is reproduced below.

1.1.2 Cyrrus Associates Limited is a company that provides consultation and services for Communication Navigation and Surveillance/Air Traffic Management (CNS/ATM) issues and has provided advice to a number of airport operators and aviation authorities on airspace matters throughout Europe since 1999. One of its core competencies is the activity known as safeguarding. The Company has undertaken several airport navigation systems safeguarding tasks in the UK and Ireland. Work has been undertaken at the following major airports: Bournemouth, Bristol Filton, Coventry, Cranfield, Exeter, Jersey, Leeds Bradford, London Heathrow and Robin Hood – Doncaster Sheffield.

1.1.3 The Company has a contract to undertake safeguarding tasks related to UK enroute surveillance radars and also has an enviable success in brokering the installation of wind turbine development in the vicinity of airports and air navigation systems.

1.1.4 Cyrrus Associates consultants have:

- Recognised qualifications in ATC Systems Engineering and operational experience in ATC matters;
- Received formal training in the use of AXIS;
- An excellent knowledge of ICAO Annex 10 and 14;
- A proven track record for conducting detailed analysis of ILS systems and presenting the findings in a concise and understandable way;
- Worked to International, European and National standards according to the regulatory requirement in the country where the task is required;
- Experience of delivering quality results to demanding timescales.

1.2 Statement Of Work

Chipshol requires the ILS expert to make a threshold assessment (worst case best case) to be used in court as an expert witness statement on the following issues:

1996 Rezoning advice LVNL

I. On September 17th 1996 LVNL wrote that we cannot consent with your draft rezoning plan in respect of a parking place submitted with the municipality of Haarlemmermeer. In connection with ILS interference the applicable area should maintain its agricultural purpose. Area AI is situated in the Glide Path interference area of the landing aid for this runway. Rezoning of this area could interfere with the proper operation of the electronic (radio) equipment, in use for a safe completion of the air traffic. The position of the ILS system is fixed to its position and cannot be moved. Because the position of the station is linked to the threshold of the runway we advise against rezoning.

a. IS THE STATEMENT THAT THE APPLICABLE AREA SHOULD MAINTAIN ITS AGRICULTURAL DESTINATION IN CONNECTION WITH ILS INTERFERENCE CORRECT?

b. CAN THE POSITION OF AN ILS BE MOVED?

c. IS IT CORRECT TO ADVICE AGAINST REZONING OF AREA A1 BECAUSE IT IS SITUATED IN THE GLIDE PATH INTERFERENCE ZONE?

1998 Rezoning advice LVNL

II. LVNL in 1998 did an assessment to the rezoning possibilities of a part of the A 1 area (area A and B). LVNL concluded in their letters of November 5th and 16th 1998 that according to our inquiry the maximum construction height in area A is 3 meters. For area B no construction and/or parking places are allowed.

It should be emphasised that the LVNL 1998 inquiry was made prior to the rezoning. Therefore not a building request but a masterplan was submitted, in which specific buildings were positioned and height lines ranging from 4 to 10 meters.

d. DOES THE SIMULATION EXECUTED LEAD TO THE CONCLUSION THAT THE BUILDING HEIGHT OF AREA A AND B WAS RESTRICTED TO RESPECTIVELY 3 AND 0 METERS?

e. IS THE STATEMENT OF LVNL CORRECT THAT DUE TO ILS RESTRICTIONS THE MAXIMUM CONSTRUCTION HEIGHT IN AREA A IS 3 METERS AND FOR AREA B NO CONSTRUCTION AND/OR NOR PARKING PLACES ARE ALLOWED?

f. WOULD CONSTRUCTION IN AREAS A AND B IN EXCESS OF RESPECTIVELY 3 AND 0 METERS LEAD TO DECLASSIFICATION OF THE ILS FROM CAT3 TO CAT 1 OR CAT 2?

g. WHICH MAXIMUM CONSTRUCTION HEIGHT IS IN YOUR OPINION ACCEPTABLE IN RESPECTIVELY AREA A AND AREA B?

h. WHICH MAXIMUM CONSTRUCTION HEIGHT IS IN YOUR OPINION ACCEPTABLE FOR THE ENTIRE GBT CONSIDERING THE THEN APPLICABLE ILS CONFIGURATION?

LVNL in their May 15th and July 23rd 1998 letters refer to a simulation.

i. COULD YOU RECOMPILE FROM THAT SIMULATION WHAT LVNL' S ASSUMPTIONS WERE AND IF SO IF THOSE WERE CORRECT CONSIDERING A BEST PRACTICE EFFORT?

j. DID LVNL ACTUALLY MAKE A SIMULATION OF PLAN A AND B IN THIS SIMULATION? IF NOT WHAT TYPE AND ORIENTATION HAD THE BUILDING ON WHICH THE SIMULATION WAS EXECUTED. PLEASE ELABORATE ON THE CONSEQUENCE OF THE ORIENTATION OF THE SIMULATED BUILDING.

k. IF YOU JUDGE THE LVNL SIMULATION WHAT ARE YOUR CONCLUSIONS?

- WAS THE ASSESMENT EXECUTED IN ACCORDANCE WITH BEST PRACTICE STANDARDS? IF NOT WHY NOT?
- IF NOT, WOULD THE RESULT HAVE BEEN MATERIALLY DIFFERENT?

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1999 Circle Freight Building Request

III. At the beginning of 1999 Chipshol submitted a specific building request for its customer Circle Freight International at the Municipality of Haarlemmermeer. The LVNL advising the Municipality of Haarlemmermeer, wrote in their advice to Haarlemmermeer that LVNL have assessed the building request of Circle Freight International and cannot approve it. LVNL objections are referenced in our letter LVB801038 of November 16" 1998.

l. IN ITS REJECTION OF THE SPECIFIC CIRCLE FREIGHT BUILDING REQUEST, LVNL REFERS TO THE MOTIVATION OF THE NOVEMBER 16TH 1998 LETTER IS THIS MOTIVATION VALID?

m. WHAT IS THE TOTAL ILS HINDRANCE CAUSED BY THE CIRCLE FREIGHT PLAN?

n. WOULD THE CONSTRUCTION OF THIS SPECIFIC PROJECT LEAD TO DEGRADATION TO CAT I OF THE ILS?

2002/2003 BUILDING STOP

IV In 2002, immediately after the rezoning was approved inevitably, Chipshol submitted specific building requests with the Municipality of Haarlemmermeer for Phase I of the area. Thereafter on February 19th 2003 a building stop was executed by the Central Government on request Schiphol Airport and LVNL. On June 6"' 2003 and therefore after the execution of the building stop, LVNL motivated the reasons for the building stop. In its report, LVNL indicated that Plans for development of the GBT near the end of the Aalsmeerbaan, had been assessed by LVNL on technical consequences at several stages. In 1998 the first global plans were assessed. At that moment, LVNL reported to the Municipality and the Province that development of the GBT would declassify the ILS 36R to category I. The specific plan (with reference number V.2002W813B101, of **September 13th 2002**) was submitted to LVNL at the end of 2002."

LVNL also stated that for its conclusion it had judged 3 different areas of the plan:

1. *What are the consequences if the entire plan as referred to in the drawing (V.2002W813B101) are to be realised (areas I, II, III, IV and V)?*
2. *What are the consequences if only those parts of the plan which are within the rezoning boundaries are realised?*
3. *What are the consequences if only areas I and IV are realised?*

From this LVNL came to the following conclusion:

The conclusion in all 3 cases is that realisation of the plan would lead to disturbance of glide path 36R. As a consequence of the planned construction and the usage of the planned construction the quality of the glidepath signal would no longer qualify to the 50% norm for static disturbance of the ICAO annex 10 maximum allowed disturbances for CAT II and CAT III. …The signal could only qualify for CAT I.

In addition LVNL states it also assessed plan V.2002W813Bl01, of **October 29th 2002** LVNL in two ways:

1 *What are the consequences if the entire plan as referred to in the drawing are to be realised (areas I, III, IV and V)?*

2 *What are the consequences if only areas I and IV are realised?*

Construction of areas I and IV (second option) cause the least disturbance of Glidepath 36R. …..Realisation of this part of the plan leads to an additional disturbance of 58.7% of the budget for static disturbance. From recent measurement flight specifications show an actual disturbance of runway 36R of 54.6% of the static budget. In total the excess of the static budget is 13.3%.

o. DOES THE CONSTRUCTION OF AREAS I AND IV CAUSE AN ADDITONAL DISTURBANCE OF 58.7%?

p. WHAT ARE THE CONSEQUENCES IF THE ENTIRE PLAN AS REFERRED TO IN THE DRAWING ARE TO BE REALISED (AREAS I, III, IV AND V)?

q. AFTER REALISATION OF THE PLANS THE REQUIREMENTS FOR CATEGORY 2 AND 3 ARE NO LONGER COMPLIED WITH LEADING TO THE DE CLASSIFICATION TO CATEGORY I.

IS THIS STATEMENT CORRECT?

3.4 Technical conclusion: Every development of the GBT would lead to additional disturbance of glide path 36R. As a result of this disturbance and the current applicable disturbance (caused by the current surroundings) the glide path signal would no longer qualify to ICAO annex 10 in respect of category 2 and/or 3 landing operations. As a result there of ILS 36R qualifies only for category I landing operations.

r. WOULD THE ADDITIONAL DISTURBANCE CAUSED BY EXECUTION OF CHIPSHOL'S PLAN V.2002W813B01 of **<u>October 29th 2002</u>** LEAD TO DE-CLASSIFICATION OF THE ILS FROM CAT-3 TO CAT-2 OR CAT-1?

s. WOULD THE GLIDE PATH SIGNAL NO LONGER QUALIFY TO ICAO ANNEX 10 IN RESPECT OF CAT 3 LANDING OPERATIONS?

LVNL used axis software for its assesment.

t. IS IT THEN IMMINENT THAT LVNL MUST HAVE KNOWN WHAT THE CAUSE FOR THE DISTURBANCE WAS IN 2003?

u. CONSIDERING THE GARBAGE IN GARBAGE OUT PRINCIPLE COULD YOU RECOMPILE FROM THAT SIMULATION WHAT LVNL' S ASSUMPTIONS WERE AND IF SO IF THOSE WERE CORRECT CONSIDERING A BEST PRACTICE EFFORT?

2005 NLR REPORT

V NLR concluded in their 2005 report that Chipshol's entire plan could be realised. Until 2006 LVNL always concluded that construction in excess of respectively 0 to 3 meters would de-classify the ILS to a class I system and that hence construction was not possible. Although NLR stated that construction of the building would not lead to any substantial disturbance of the ILS it does state that the Truck parking caused excess disturbance.

v. IS THE ILS DISTURBANCE CAUSED BY PLAN V.2002W813B01 (INCLUDING TRUCK PARKING) IN EXCESS OF THE APPLICABLE LIMITS?

w. WAS THE REMAINING ILS HINDRANCE IN THE NLR REPORT CALCULATED CORRECTLY? IF NOT WHAT WAS THE CORRECT ILS HINDRANCE BUDGET?

x. IS DISTURBANCE CAUSED BY TRUCKS TO BE CONSIDERED AS STATIC OR DYNAMIC DISTURBANCE?

y. IF THE TRUCKS CAUSED EXCESS HINDRANCE WOULD THERE BE A (SIMPLE) SOLUTION TO SOLVE THIS?

VI. LIB

z IF YOU CONSIDER THE HEIGT RESTRUCTIONS UNDER THE LIB AS SET OUT IN THE ATTACHMENT CAN YOU VALIDATE IF THOSE RESTRICTIONS ARE MANDATORY UNDER EITHER ICAO ANNEX 10 OR ANNEX 14 ?

aa PROVIDED ICAO ANNEXES 10 AND OR 14 PROVIDE FOR MANDATORY HEIGHT LIMITATATIONS FOR THE GBT DO YOU CONSIDER THE HEIGHT LIMITATIONS AS SET OUT IN THE ATTACHMENT CORRECT. ARE THE LIMITATIONS MORE STRICT THAT WHAT ONE WOULD HAVE EXPECTED?

VII. General questions:

ab CONSIDERING THE ENTIRE OUTCOME AND THE CONDUCT OF LVNL FROM 1996 TO 2005 WOULD YOU CONSIDER LVNL' S CONDUCT A BEST PRACTICE CONDUCT?

ac DETERMINE THE LOCATION AND HEIGHT OF FUTURE DEVELOPMENTS OF AVAILABLE REAL-ESTATE ON GBT INCLUDING TRUCKPARKING. DETERMINE AREA WHERE NO DEVELOPMENTS CAN BE CONDUCTED.

2 Background to Groenenbergterrein Development

2.1 An application for rezoning of the GBT was submitted in 1996. This was opposed by LVNL as it was stated that development would have adverse effects on the electronic (radio) equipment serving runway 36R at Schiphol Airport. An analysis of the LVNL 1996 rezoning objection is detailed in Section 4 of this report.

2.2 In 1998, Chipshol requested LVNL to assess potential development in two areas of the GBT identified as Areas A and B. development was opposed on the basis that the effects on the ILS glidepath would result in the downgrading of the ILS. LVNL stated that for areas A and B maximum building heights applied of respectively 3 and 0 metres. An analysis of the LVNL technical assessment is detailed in Section 5 of this report.

2.3 In 1999, Chipshol developed a specific plan for the Circle Freight facility. This plan was also refused by LVNL based on the assessment carried out in 1998. An evaluation of the effects of the Circle Freight facility on ILS performance is detailed in Section 7 of this report.

2.4 In November 2002, Chipshol submitted a revised building plan GBT813bl01 dated Oct 29th 2002. In February 2003, a Building Stop order was placed on Chipshol on the basis that the development would result in degrading of the ILS glidepath. LVNL submitted data to justify the Building Stop based on AXIS ILS Simulation and concluded that the findings would result in degrading of the ILS Glidepath Performance Category. An analysis of the LVNL technical assessment of Building plan GBT813bl01 dated Oct 29th 2002 is addressed in Section 7.

2.5 The June 2003 ILS assessment carried out by LVNL was further analysed by NLR. The NLR findings were that only the truck parking created sufficient disturbance to the ILS to be of any concern. An analysis of the NLR report is addressed in Section 6.

2.6 In October 2006, Chipshol engaged Cyrrus Associates Ltd to assess the ILS safeguarding process that had been undertaken on the GBT and to advise Chipshol on the unresolved ILS issues. Details of the investigation are contained within this report.

3 Safeguarding of Aerodromes

3.1 General

3.1.1 To ensure the safety of aircraft using airports, it is necessary that the environment of the airport is controlled to reduce any risks that may arise. This control is exercised by way of safeguarding.

3.1.2 Any proposed building developments on the airport or within defined local areas must be assessed to determine if there is any adverse effect on aircraft safety or indeed the commercial operation of the airport which may arise as a consequence of ensuring safety in the presence of building developments.

3.1.3 There are four aspects to airport safeguarding:

Physical Safeguarding.

3.1.4 Physical safeguarding is the control of buildings or constructions that could pose a physical obstacle and hence risk of collision to aircraft using the airport. Annex 14 to the International Convention on Civil Aviation defines Obstacle Limitation Surfaces (OLS) which are imaginary surfaces around a runway where the control of obstacles is required. The specifications of the surfaces are dependant on the runway size and its intended use. This is usually presented in the form of a colour coded map illustrating maximum building heights permitted in various areas around the runway out to a maximum range of 15km.

Technical Safeguarding

3.1.5 Technical safeguarding applies to radio communication, navigation, and surveillance facilities. The purpose of technical safeguarding is to protect the performance and integrity of the facility to ensure that the service provided by the facility is safe and meets defined international standards.

Procedure Safeguarding

3.1.6 Suitably equipped aircraft may use radio navigation facilities to provide guidance to a runway (Instrument Approach procedure). The height to which an aircraft may descend on any published instrument approach procedure is determined by the obstacle environment around the flightpath. Additional obstacles may raise the minimum descent height, thus reducing the availability of the procedure at times of low cloud or poor visibility.

Public Safety Zones

3.1.7 In recent years, there has developed an increasing awareness of risk and safety, especially in an increasingly litigious society. An additional safeguarding area is now being applied around runways based on statistical risk of aircraft accident or incident. Based on statistical analysis of aircraft accidents, risk contours are defined around a runway. These ‘Public Safety Zones’ or PSZ are intended to identify areas where the risk of aircraft accident is higher than a desired target and in which development of housing and public facilities is discouraged. The PSZ for runway 36R does encompass part of the GBT site.

3.2 Safeguarding of ILS

3.2.1 The ILS provides both lateral and vertical guidance by means of radio signals to enable aircraft to approach and land without visual reference to the ground in times of poor visibility. By using this system, approach and landing may be carried out either automatically or by suitable instrument guidance to the pilot. To ensure the safety and integrity of such systems, it is necessary to provide a high level of safeguarding of the system performance.

3.2.2 Lateral guidance is provided by the ILS localiser which is located beyond the far end of the runway on the extended runway centreline. Vertical guidance is provided by the ILS glidepath, located around 300m from the runway threshold and offset by around 120m from the runway centreline.

3.2.3 The reflection of ILS signals from reflecting objects, whether buildings or terrain, create multipath reception at the aircraft receiver which acts to distort the guidance beam. The technical specification for ILS and the tolerance on beam distortions is mandated in Annex 10 (Aeronautical Telecommunications) to the International Convention on Civil Aviation [1]. This document is adopted by all members of the International Civil Aviation Organisation (ICAO).

3.2.4 To protect ILS performance and integrity, three areas are defined.

- The ILS critical area is an area of defined dimensions about the localizer and glide path antennas where vehicles, including aircraft, are excluded during all ILS operations. This is the area in which the ILS beam is formed. The critical area is protected because the presence of vehicles and/or aircraft inside its boundaries will cause unacceptable disturbance to the ILS signal-in-space.[1]
- The ILS sensitive area is an area extending beyond the critical area where the parking and/or movement of vehicles, including aircraft, is controlled to prevent the possibility of unacceptable interference to the ILS signal during ILS operations. The sensitive area is protected against interference caused by large moving objects outside the critical area but still normally within the airfield boundary. [1]
- The ILS safeguarded area is an area where development could potentially affect the performance of the ILS. These areas are defined by the ILS operator. Any development within these areas must be assessed to determine the probability of adverse effects on the ILS beam.

3.2.5 It can be seen from the international definitions of the critical and sensitive areas, that they are designed to reduce the possibility of dynamic bends caused by moving vehicles and aircraft, not static bends caused by terrain and fixed structures.

3.2.6 The purpose of safeguarded areas is not to prevent development. The purpose is to identify where development could potentially have an adverse effect on ILS performance. Any such proposed development which infringes the defined safeguarded areas should be subject to a technical safeguarding assessment to ensure the ongoing safe operation of the ILS. Development that does not infringe the safeguarded areas is normally acceptable.

3.2.7 There are no mandated dimensions for safeguarded areas, and each state has traditionally determined their own criteria based on generic system performance. In September 2004, ICAO Europe published ICAO EUR DOC 15 *European Guidance Material On Managing Building Restricted Areas* [3]. This European document gives guidance on the establishment of safeguarded areas and management of safeguarding for all radio navigation facilities. The guidance defines much larger safeguarded areas for ILS than have traditionally been adopted and are very conservative to take into account various ILS equipment configurations and categories of operation.

3.2.8 Irrespective of the safeguarding area definition chosen, the Groenenbergterrein falls within the technical safeguarding area of the ILS glidepath.

3.2.9 The Groenenbergterrein also falls within most definitions of the technical safeguarding area of the ILS localiser. In many respects, the ILS localiser is the most critical part of the system for ILS Category III autoland operations.

3.3 Groenenbergterrein

3.3.1 The planned developments of the GBT as per GBT813bl01B and GBT817bl01B do not infringe internationally accepted definitions [1] of the ILS glidepath Critical or Sensitive areas. The rezoned part of the GBT for which the development is proposed is located in the Safeguarded area.

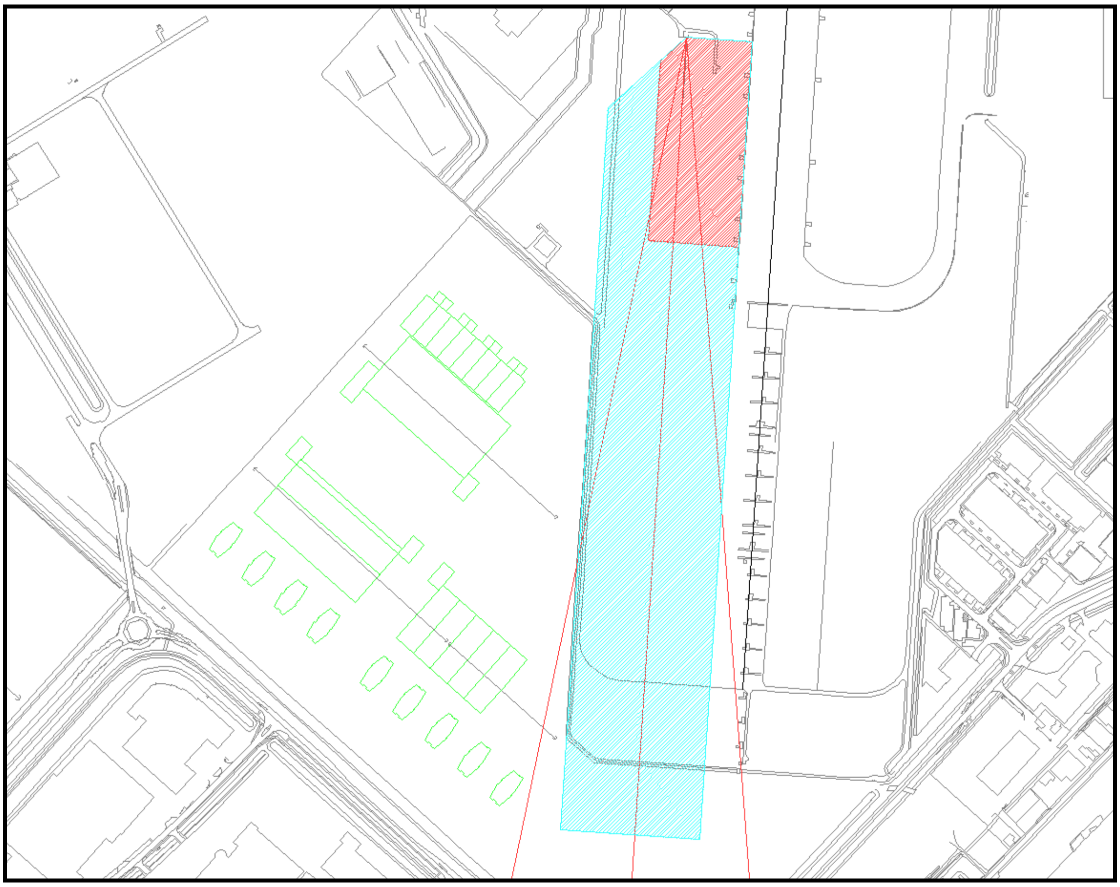


Figure 1. ILS Glidepath Critical and Sensitive areas.

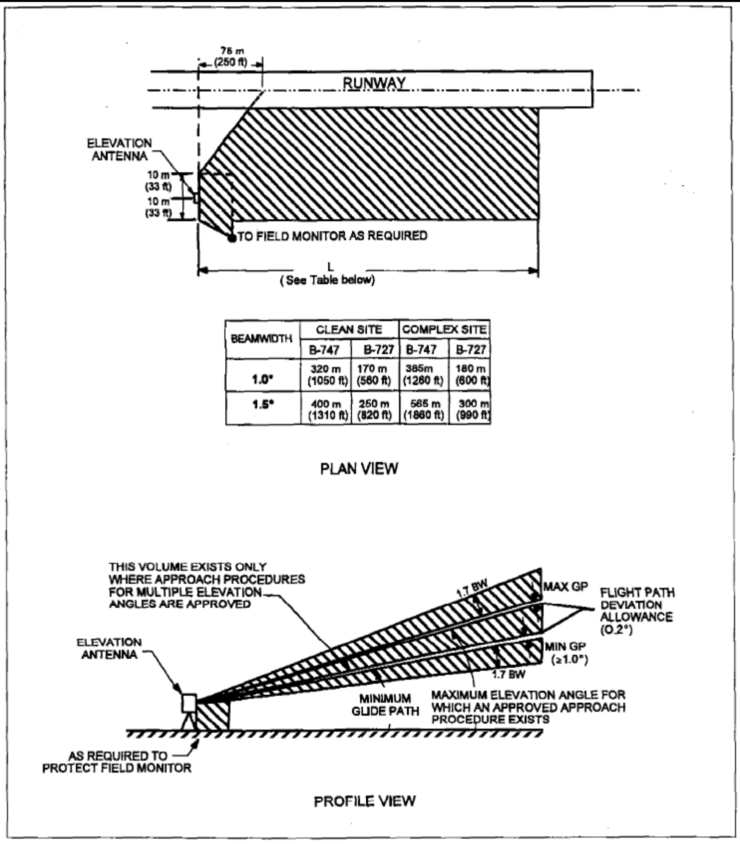
3.3.2 In Figure 1, the ILS glidepath critical area is shaded red, and the sensitive area shaded in cyan. The GBT planned development shown in green is outside of these areas. The red lines illustrate the lateral coverage of the ILS glidepath of ±8°. The sensitive area would normally terminate at the airfield boundary as the airport operator has no control of vehicle movements outside of the airport.

3.3.3 The safeguarded area will be specified by the national regulatory authority. As mentioned, the GBT falls within most definitions of ILS glidepath safeguarded areas. This in itself does not preclude development of the GBT, but means that the airport operator must be satisfied that any development does not affect the ongoing safe operation of the ILS. This is normally achieved by computer simulation of the effects of the proposed development.

3.3.4 LVNL letter LVB 800456 refers to a Protected Zones document produced by BFS in Germany which defines the German application of critical and sensitive areas for ILS glidepaths. Whilst this is interesting, the proposed development of the GBT falls outside of the zones mentioned, which are in any case designed to protect against dynamic bends caused by moving vehicles and aircraft.

3.3.5 The MLS critical and sensitive areas are generally smaller than those for ILS, indeed this was the basis of the business case for the installation of MLS at

Schiphol and London Heathrow. In LVNL letter reference LVB 801038 of 16th November 1998, the MLS elevation critical/sensitive area is defined as 600m at ±43° around the centreline where no development is permitted. The critical areas for MLS are defined in Attachment G to ICAO Annex 10 [1] and are illustrated in Figure 2.



BEAMWIDTH	CLEAN SITE		COMPLEX SITE	
	B-747	B-727	B-747	B-727
1.0°	320 m (1050 ft)	170 m (560 ft)	385m (1260 ft)	180 m (600 ft)
1.5°	400 m (1310 ft)	250 m (820 ft)	565 m (1860 ft)	300 m (990 ft)

Figure G-24. Typical elevation critical and sensitive areas/volume

Figure 2. MLS Elevation Critical areas (ICAO Annex 10)

3.3.6 As can be seen, the critical area is quite small compared to the ILS Glidepath. An extension of critical area is allowed by ICAO to protect Area Navigation (RNAV) based on MLS (curved approaches). This extended area is shown in Figure 3. This is the criteria that LVNL appear to have applied to the MLS at Schiphol runway 36R.

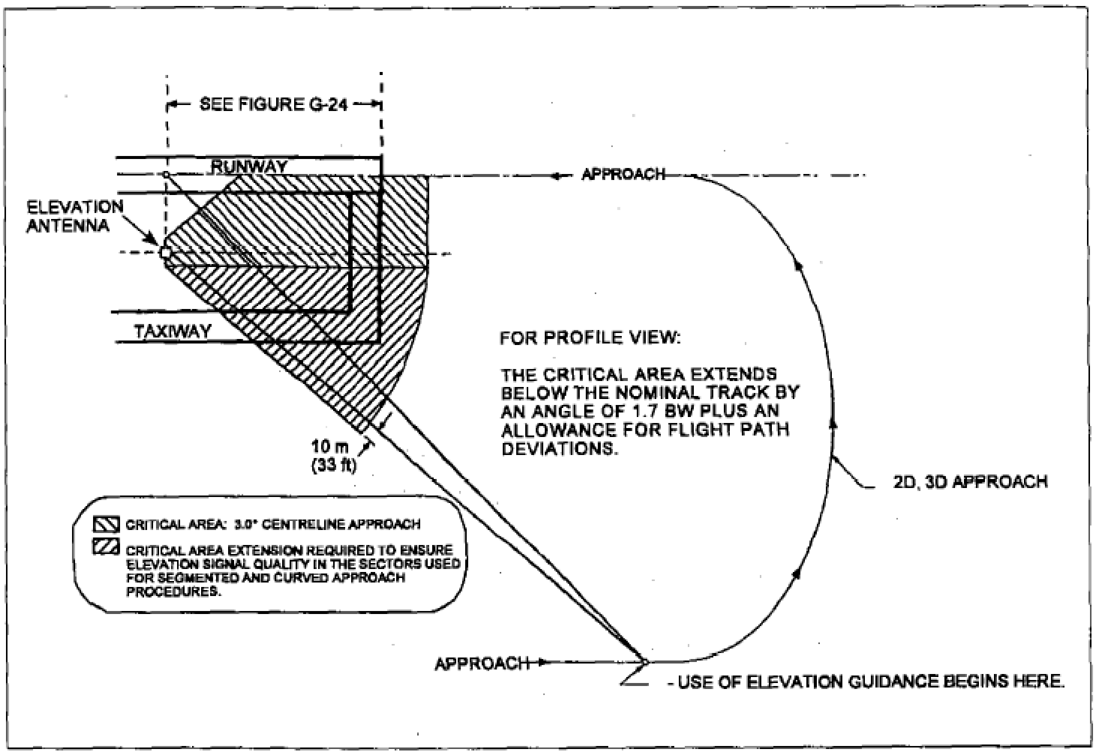


Figure G-28. Typical extension of the elevation critical area for segmented and curved approach procedures

Figure 3. Extended MLS critical area for RNAV (ICAO Annex 10).

3.3.7 MLS/RNAV was considered in the 1970s as a means of providing curved or segmented approach paths unlike ILS which is limited to a straight line approach. The advent of satellite navigation for RNAV has subsequently made the requirement for MLS/RNAV unnecessary. The existing implementations on Boeing and Airbus commercial airliners only facilitate straight in MLS approaches in the same way as ILS. Curved approaches to the straight line MLS final approach segment are made using multi-sensor RNAV which does not utilise the MLS signal.

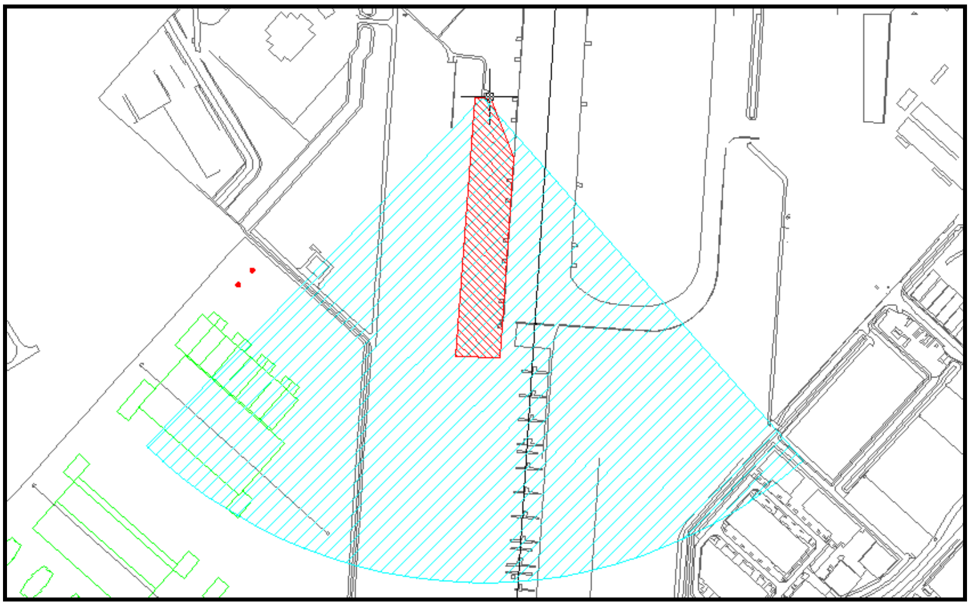


Figure 4. MLS Critical Areas

3.3.8 Figure 4 illustrates the basic MLS critical area (red) compared to that stated in LVNL letter LVB 801038 (cyan).

3.3.9 The safeguarding surfaces for MLS Elevation facilities stated in ICAO EUR DOC 015 of September 2004 [3] are the most conservative application of safeguarding criteria. These are depicted in Figure 4a.

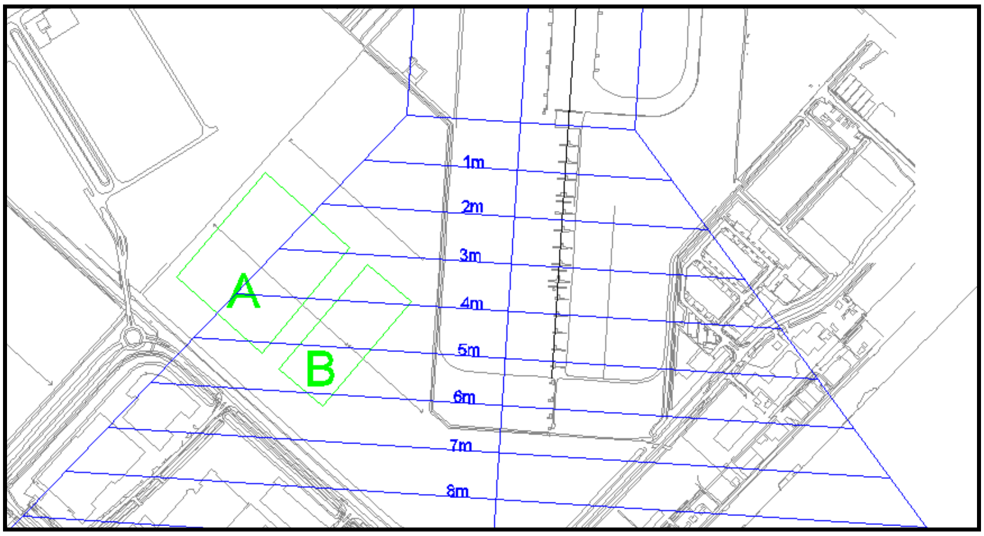


Figure 4a. ICAO EUR DOC 015 MLS Elevation safeguarding surfaces.

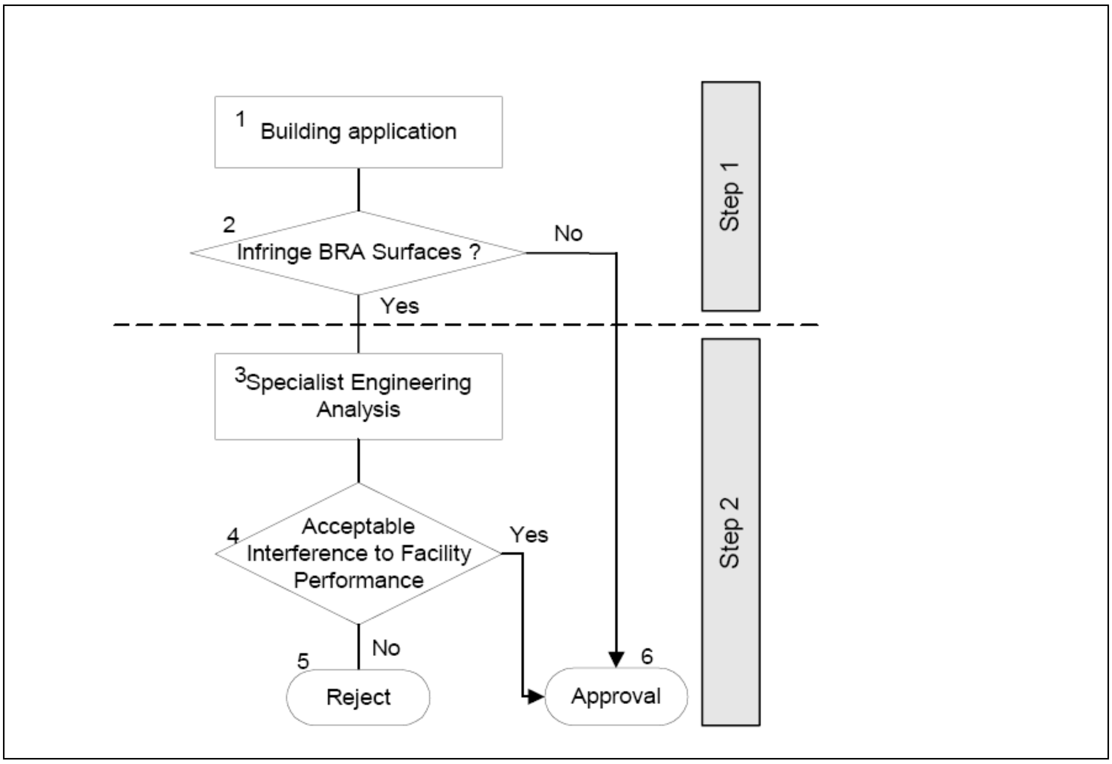
3.3.10 The Safeguarding surfaces do not preclude construction; ICAO EUR DOC 015 states that safeguarding is a two step process. If the building is lower than the safeguarded surface, then no action is necessary. If the surface is penetrated, then an engineering evaluation is required to determine the acceptability of the building proposal.

3.3.11 An extract of the relevant section of ICAO EUR DOC 015 is shown in the following paragraphs and diagram.

3.3.12 EUR DOC 015 Section 4

> *4.1 The general procedure is a two-step process (see Figure 1) for the approval of buildings that may adversely affect CNS facilities.*
>
> *4.2 The analysis carried out under both processes should be formally recorded. The intention is that Step 1 should be an expedient evaluation and Step 2 should involve in-depth analysis.*
>
> *4.3 For Step 1: Use the General Input Screening method for all applications. This screen is to be used by the appropriate authorities (for example: Airport, Planning, Local Official, Government Authorities who conduct the initial review of building applications) in order to ascertain whether approval can be given directly or it should be passed to the appropriate engineering authorities (Air Traffic Safety Electronic Personnel - ATSEP).*
>
> *4.4 For Step 2: The ATSEP should carry out detailed analysis. This should cover all aspects of the CNS facility to be protected and the possible effects of the proposed building on the signal in space provided by these facilities.*

Extract from ICAO EUR DOC 015



EUR DOC 015 Figure 1

3.3.13 As there are currently no implementation of MLS RNAV, and no plans to implement it in the future on commercial airliners, the application of the more stringent criteria appear wholly inappropriate at Schiphol. It would be more reasonable to protect ±10° around the approach rather than ±40° for the reasons stated previously.

3.4 ILS Technical Safeguarding Process

3.4.1 The primary objective of ILS Safeguarding is to ensure the ongoing safe operation of the ILS. The secondary objective is to allow development in a controlled manner whilst ensuring that the primary objective continues to be met.

3.4.2 If a development falls within the safeguarding area, the safeguarding process for a proposed development in the presence of ILS can normally be considered in six stages. This process is illustrated in Figure 5.

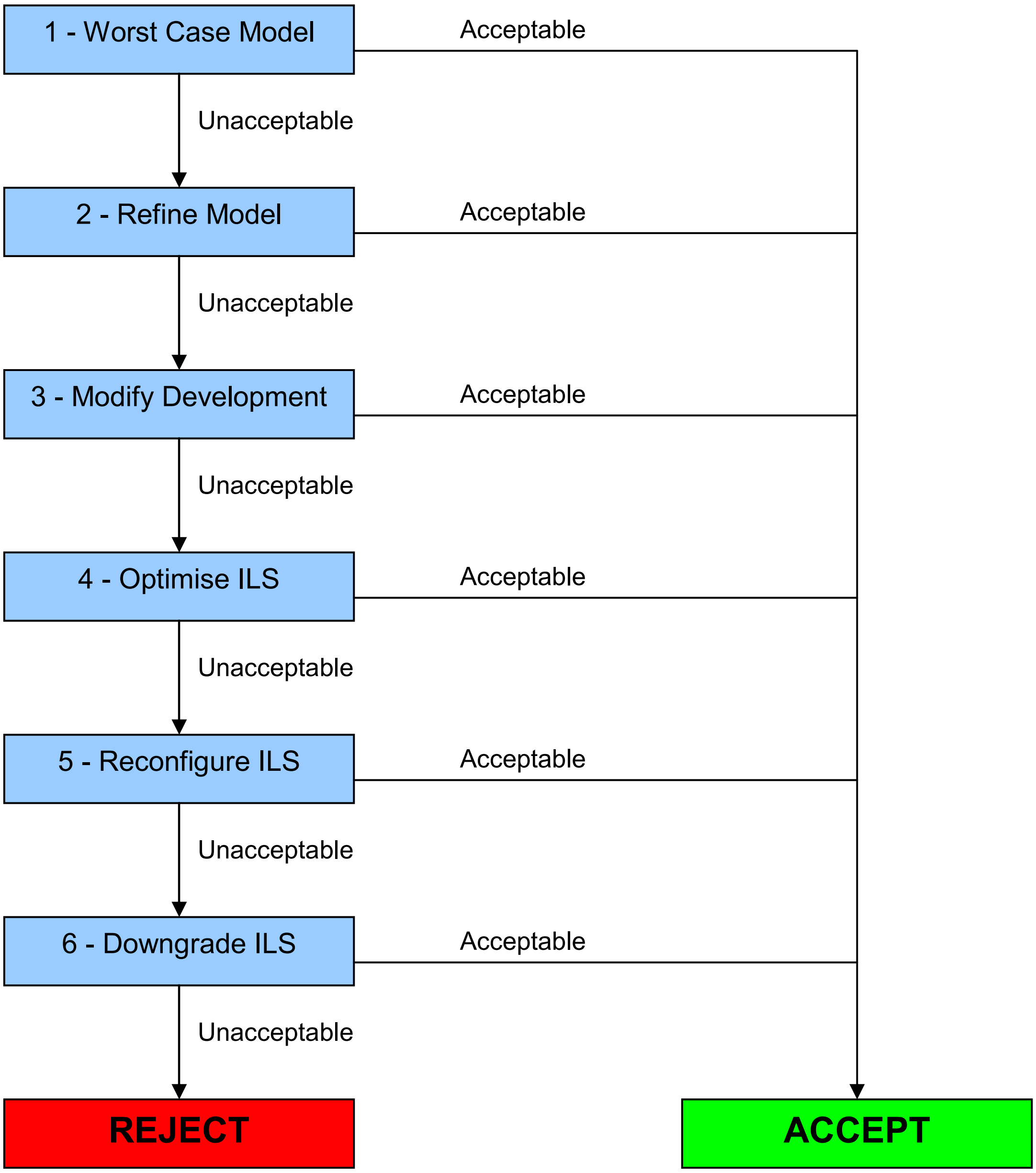


Figure 5. Nominal ILS Safeguarding Process

3.4.3 The stages of safeguarding in Figure 5 are normally undertaken as follows:

- A worst-case computer simulation is made outlining the development as a series of perfectly reflecting smooth metal sheets. If the results of the worst-case model show acceptable degradation to the ILS signal parameters, then no further investigation is normally needed and the development is accepted. If the effects are unacceptable, then the safeguarding process moves on to stage 2.
- The worst-case computer simulation is now refined to more accurately represent the proposed development. This includes using actual proposed building dimensions, orientations and better representation of the construction materials proposed. If the results show acceptable degradation to the ILS signal parameters, then no further investigation is normally needed and the development is accepted. If the effects are unacceptable, then the safeguarding process moves on to stage 3.
- The third stage is to identify possible mitigations in the design of the proposed development. These may include reducing building heights, changing the orientation of buildings, change of building materials, change of building layout, modifications to building shapes or the addition of screening or shadowing structures. If the results show acceptable degradation to the ILS signal parameters, then no further investigation is normally needed and the development is accepted. If the effects are unacceptable, then the safeguarding process moves on to stage 4.
- It is possible to optimise the ILS signal to some extent by electrical and/or mechanical modifications to the ILS equipments and antennas. The degree of optimisation available depends on the configuration of the system, and optimisation is not always possible. Generally, ILS can only be optimised to deal with one specific problem and cannot be adapted for multiple developments. If the results show acceptable degradation to the ILS signal parameters, then no further investigation is normally needed and the development is accepted. If the effects are unacceptable, then the safeguarding process moves on to stage 5.
- A more radical step may be to consider upgrading the ILS equipments to a configuration that is unaffected by the proposed development, or even relocation of the equipments. If this stage is ineffective then only option 6 remains.
- If all other mitigation measures fail to safeguard the ILS performance, then downgrading of the ILS facility performance category may be considered as the only option for the development to proceed. This decision is not taken lightly, for example, an Airport operator may be prepared to sacrifice ILS performance for the sake of building a new terminal following a cost benefit analysis.

3.4.4 This is an outline of the best practice process that developers and airport operators would normally be expected to follow.

3.5 ILS Simulation Software

3.5.1 The formation of ILS guidance beams by the vector sum of radio signals from multiple antennas and ground reflections is a very complex process. The advent of data analysis by computers in the last quarter of the 20th century allowed much more detailed investigation and analysis of ILS signal in space performance.

3.5.2 Commercial ILS software engineering, analysis and training tools have been developed by Nanco in Norway and Ohio University in the USA. These are the most widely used ILS simulation tools worldwide and have been validated against each other. First released in the 1980s, each tool has undergone development and expanded functionality as available computing power has increased.

3.5.3 There are other bespoke ILS software based modelling tools which are proprietary to the individual companies that have developed them. These are however not commercially available to third parties. Most National Aviation Authorities and ILS companies in Europe and elsewhere use either the Nanco or Ohio models.

3.5.4 Cyrrus Associates and LVNL utilise the suite of ILS modelling programs produced by Nanco software. Nanco produces AXIS 110 for ILS Localiser analysis and AXIS 330 for ILS Glidepath analysis. Cyrrus Associates staff have undergone extensive training in AXIS simulation and have contributed to the ongoing development of the software.

3.5.5 The current and latest release version of the software licensed to Cyrrus Associates is Release 39 dated 2nd October 2002.

3.6 ILS Modelling and Simulation

3.6.1 It is considered useful to explain some aspects of ILS modelling and simulation and the behaviour and characteristics of the modelling tools at this point.

3.6.2 ILS signals will be reflected and diffracted by any objects that are illuminated by the RF radiation from the ILS antennas. If the antenna is considered as a light bulb, light will be reflected from objects that the light falls on. Similarly, if an object is not illuminated by the ILS, it will not reflect the RF energy which causes distortions to the ILS pattern. Therefore, when modelling a development, only those faces illuminated by the ILS are considered.

3.6.3 One of the characteristics of the AXIS model is that it considers the effect of reflections and diffraction for each individual object modelled and computes the resultant effect on the ILS system parameters. As a consequence of this, if a small object is shielded behind a large object, the model would calculate the result as if both objects were fully illuminated. It is therefore very important that when a series of objects are modelled, that only the illuminated surfaces of each component are considered.

3.6.4 Energy can be reflected from one object to another, it is therefore important that the objects are entered into the model in the order in which they are illuminated, i.e. in order of distance from the ILS antenna.

3.6.5 The simulation is based on a large number of parameters relating to the facility under investigation. For each ILS type, the simulation software offers a default set of parameters. These must be modified to represent the actual specification of the ILS, relating to equipment siting and configuration in order to obtain a correct result.

3.6.6 Whilst the simulation will show the theoretical outcome of any particular scenario, there remains a variable element as each aircraft using the ILS will have differing receiver and antenna characteristics. The aircraft will also have differing approach speeds and varying drift angles depending on cross-winds. The drift angle will modify the aircraft antenna pattern and the relative levels of the wanted and reflected signals. It is therefore normal to allocate only part of the overall ILS tolerance to theoretical static bends resulting from simulation. The allowance for static bends varies between states and is not mandated. Guidance is given in Attachment C to part 1 of ICAO Annex 10 [1] where examples show up to 80% of the total budget allocated to static bends for Cat III ILS. LVNL reserve 50% of the bend tolerance to be allocated to static bends.

3.6.7 Any country that is a signatory to ICAO is required to file a difference with ICAO if they do not adopt any particular ICAO mandates or do things differently to the requirements of the ICAO Annexes. The Netherlands has not filed any differences to ICAO Annex 10 [1] or to ICAO Annex 14 Chapter 4 "*Obstacle Restriction and Removal*" [2]. Reference Netherlands AIP [6].

4 LVNL Rezoning Objection 1996

4.1 On September 17th 1996 LVNL submitted an objection to the draft rezoning plan in respect of a parking place submitted with the municipality of Haarlemmermeer. The objection was in connection with ILS interference and contested that as such the applicable area should maintain its agricultural purpose. LVNL stated that area AI is situated in the Glide Path interference area of the landing aid for the runway. Rezoning of this area could interfere with the proper operation of the electronic (radio) equipment; in use for a safe completion of the air traffic. LVNL also stated that the position of the ILS system is fixed to its position and cannot be moved because the position of the station is linked to the threshold of the runway. LVNL advised against rezoning.

4.1.1 The objection seems to be based on the GBT being within the safeguarding area for the ILS glidepath, as the area is outside the critical and sensitive areas for the ILS glidepath (see Figure 1).

4.1.2 Infringement of a safeguarding area is not in itself sufficient reason to object to a planning application. It is merely an indication that a technical assessment is required to ensure the ongoing safe operation of the facility. It is not evident that best practice, outlined in ICAO EUR DOC 015, has been followed in this case.

4.1.3 No evidence of any effects on the ILS glidepath has been presented at this time to justify the objection.

4.1.4 The second part of the statement is technically incorrect. The ILS glidepath could be relocated to the east side of the runway. There may be good technical and operational reasons as to why this would be unacceptable, but it is technically feasible.

5 LVNL Safeguarding Evaluation 1998 (Areas A and B)

5.1.1 This section provides a critique of the initial ILS safeguarding evaluation on the Groenenbergterrein carried out in May 1998 and issued under LVNL Letter of 15th May 1998 reference LVB 800456 and LVNL Letter of 28th May 1998 reference LVB 800482. The analysis undertaken is purely to assess the validity of the parameters used and the results derived from the original simulation.

5.2 Baseline Analysis

5.2.1 The LVNL analysis was carried out on the ILS glidepath using AXIS 330 modelling software. It is assumed that the version was R33 or earlier. Cyrrus Associates is using the latest release version R39. From the software change history, there should be no differences in the results as this area of the software has not been changed. To establish a baseline, the LVNL modelling data was entered into version R39 and the results compared.

5.2.2 The graphs in Figures 6 and 7 show the simulated course structure of the ILS glidepath beam. Ideally, this beam would be a straight line. The actual course structure is the vector sum of the directly radiated signal plus reflections of the signal from objects, buildings and terrain.

5.2.3 International limits are placed on the maximum beam disturbance. These limits are defined in ICAO Annex 10 [1]. The maximum bend tolerance lines for Category III ILS Glidepath are indicated on the graphs by the funnel shaped lines. The tolerance is ±30µA at Point A on the graph, decreasing to ±20µA at Point B on the graph (Zone 2). The tolerance then remains at ±20µA to Point T on the graph (Zone 3). Predicted disturbance is shown numerically on the Cyrrus Associates graphs for Zones 2 and 3.

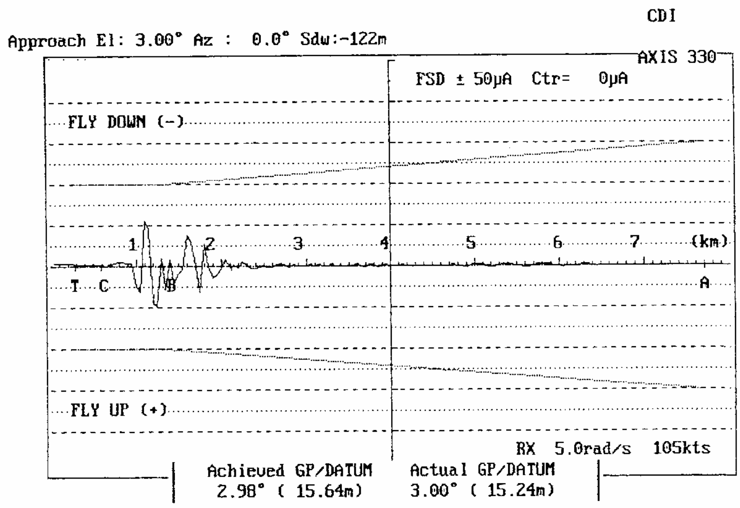
```
Computed on AXIS 330,  14 July 1998  13:04:54
++++++++++++++++++++++++++++++++++++++++++++++++
M-ARRAY/CEGS @ Fly Right   Elmt KATHREIN  2L  Gnd  MOIST EARTH

RF-Frq  GP     FSL    SSL   RWY  Rtc  Rts   Phx    ClrA  ClrD    SBOA    SBOP
333.8   3.00| 0.000 0.000 122m 50.0 50.0 180.0|   0.0  343uA   0.0dB   0.0|

Ant Height  Offs  Fwd shift  Azim  CSBA  CSBP   SBOA  SBOP  | Ampl  Phase
 3  12.88m -0.38m   0.00cm   0.0|   0.0   0.0|  5.84 180.0|| 100%     0|
 2   8.59m  0.00m   0.00cm   0.0|  50.0 180.0| 11.67   0.0|| 100%     0|
 1   4.29m  0.23m   0.00cm   0.0| 100.0   0.0|  5.84 180.0|| 100%     0|

Scatter objects
 # Type Fwd    Sdw    Lgt    Hgt/d  Hgt-II    Rot   Tilt/#  Rfl Opt Setup
 1 (S)  550m  230m 300.0m   10.0m  0.0m     0.0|   0.0|   1.00
 2 (S)  550m  330m 300.0m  200.0m 10.0m     0.0|  90.0|   1.00
```

Configuration data for model



Result of simulation

Figure 6. LVNL Analysis July 1998.

Explanation of result page shown in red

5.2.4 Upper line and lower lines on the graph reflect the total error budget. The existing disturbance (error) should be deducted from this. For the calculation of the remaining error budget reference is made to Section 7.10 Error Budget.

Computed on [AXIS 330], 18 Oct. 2006 15:50:58 Schiphol 36R

M-ARRAY/CEGS @ Fly Right Elmt KATHREIN 2L Gnd MOIST EARTH

RF-Frq	GP	FSL	SSL	RWY	Rtc	Rts	Phx	ClrA	ClrD	SBOA	SBOP
333.8	3.00	0.000	0.000	122m	50.0	50.0	180.0	0.0	257uA	0.0dB	0.0

Ant	Height	Offs	Fwd shift	Azim	CSBA	CSBP	SBOA	SBOP	Ampl	Phase
3	12.88m	-0.38m	0.00cm	0.0	0.0	0.0	5.84	180.0	100%	0
2	8.59m	0.00m	0.00cm	0.0	50.0	180.0	11.67	0.0	100%	0
1	4.29m	0.23m	0.00cm	0.0	100.0	0.0	5.84	180.0	100%	0

Scatter objects

#	Type	Fwd	Sdw	Lgt	Hgt/d	Hgt-II	Rot	Tilt/#	Rfl	Opt Setup
1	(S)	550m	230m	300.0m	10.0m	0.0m	0.0	0.0	1.00	
2	(S)	550m	330m	300.0m	200.0m	10.0m	0.0	90.0	1.00	

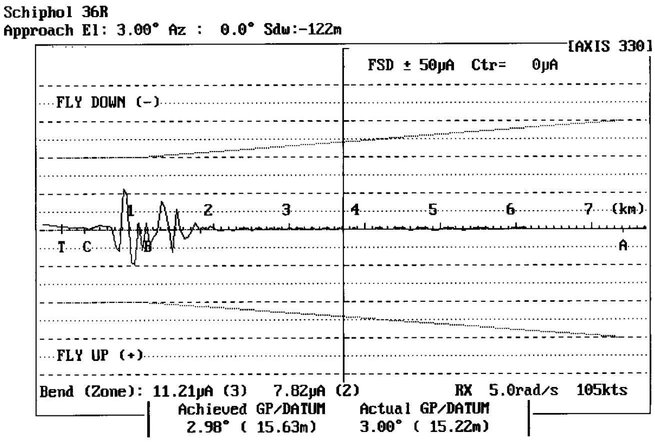


Figure 7 Cyrrus Associates validation of LVNL assessment.

5.2.5 The output of the model in both cases is identical. Having established that the modelling is the same, the assumptions made in the LVNL model are now analysed.

5.3 Scatter Objects

5.3.1 As stated in Section 3.4, it is normal process to establish a worst-case scenario to determine if the beam bend potential is acceptable. The Groenenbergterrein in the LVNL model has been modelled as two flat metal plates which act as scattering objects within the model. The placement of the plates was analysed by placing them in an AutoCAD drawing to better visualise the layout. The result is shown in figure 8.

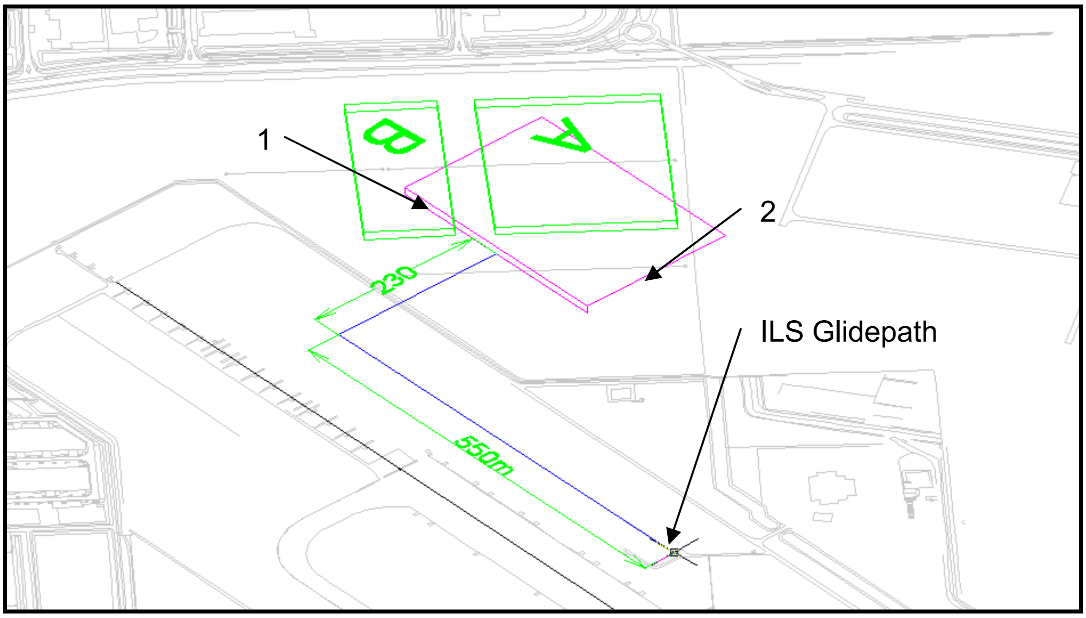


Figure 8. LVNL ILS Model

5.3.2 Figure 8 illustrates the configuration of the LVNL model. The magenta object is that modelled by LVNL in the AXIS simulation. The LVNL model represents the face of a metal clad building, 300m long and 10m high, parallel to the runway, with the roof of the building which is 200m wide. The structure as modelled infringes on land that is outside of the Groenenbergterrein. Areas A and B are shown for reference.

5.3.3 AXIS 330 places the objects relative to the glidepath centreline, not the runway centreline. In this instance, the face of the building has been placed 230m from the glidepath centreline or 350m from the runway centreline. For a worst-case model, the face of the building should be placed within the Groenenbergterrein closest to the runway. This would be 230m from the runway centreline but only 110m from the glidepath centreline.

5.3.4 It is not evident as to why the roof of the building was modelled. As mentioned in section 3.6, only those faces of an object that are illuminated by ILS signals are modelled. The roof element would not receive direct radiation from the ILS as it would be screened by the end face. In this instance, the top surface of the roof would only receive radiation from the upper ILS antenna, not a composite signal from all three antennas. In the second scenario modelled by LVNL, the height of the face and roof are raised to 15m, which is in excess of the heights of all ILS antennas.

5.3.5 As only two surfaces have been modelled, the individual beam bend contributions were investigated. These are shown in the following figures.

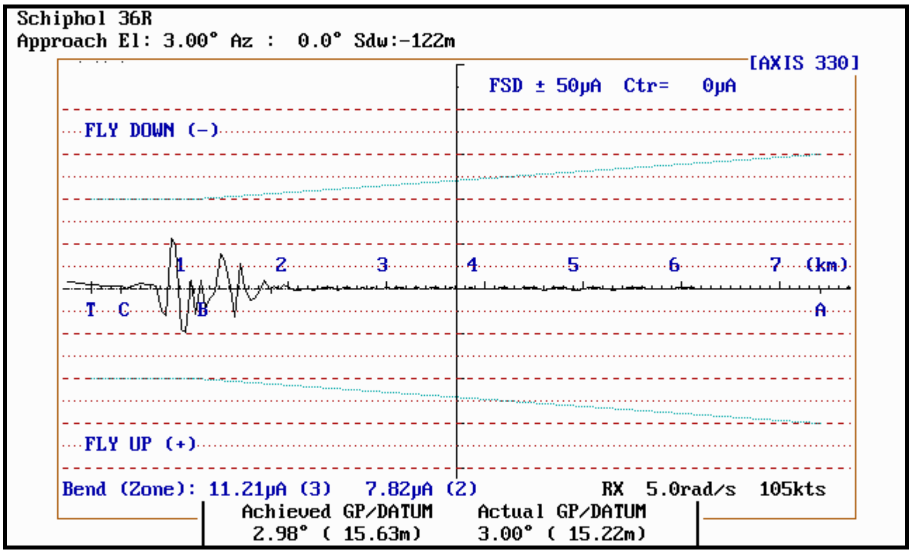


Figure 9. LVNL original model

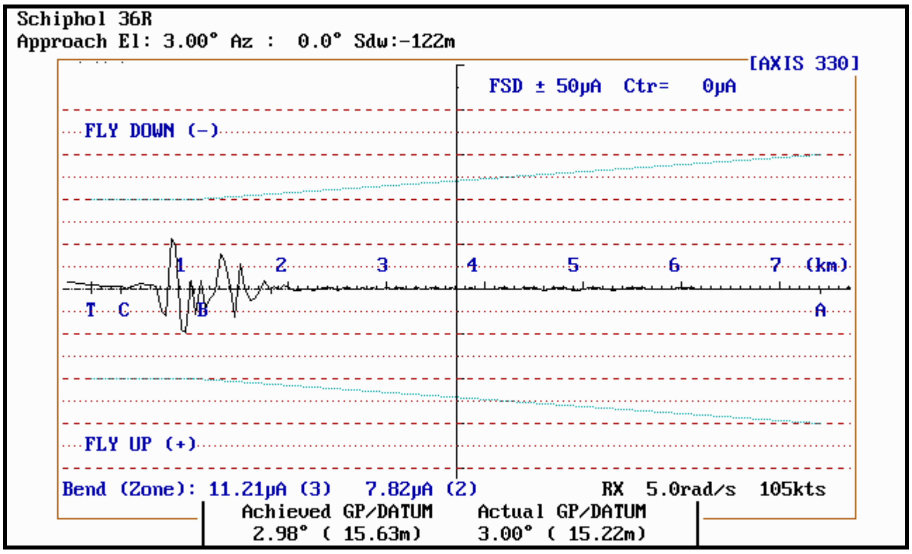


Figure 10. LVNL Object 1 only (Vertical face of building)

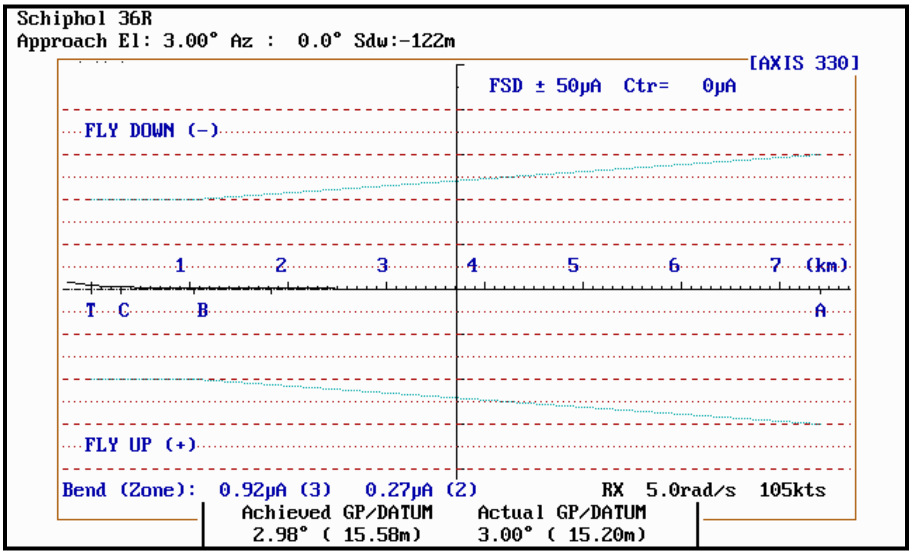


Figure 11. LVNL Object 2 only (Roof of building)

5.3.6 As the analysis shows, the roof adds no significant contribution to the overall beam bends. The bend contribution is almost entirely from the vertical face.

5.4 Configuration of Model

5.4.1 AXIS 330 offers a significant number of parameters that the user may set up to accurately represent the system under investigation. The model has a set of default parameters when initially run. These parameters set such things as ILS configuration, antenna heights, antenna location, terrain profiles etc. The main control panel is shown at figure 12. There are further configurations for each analysis and graphic option.

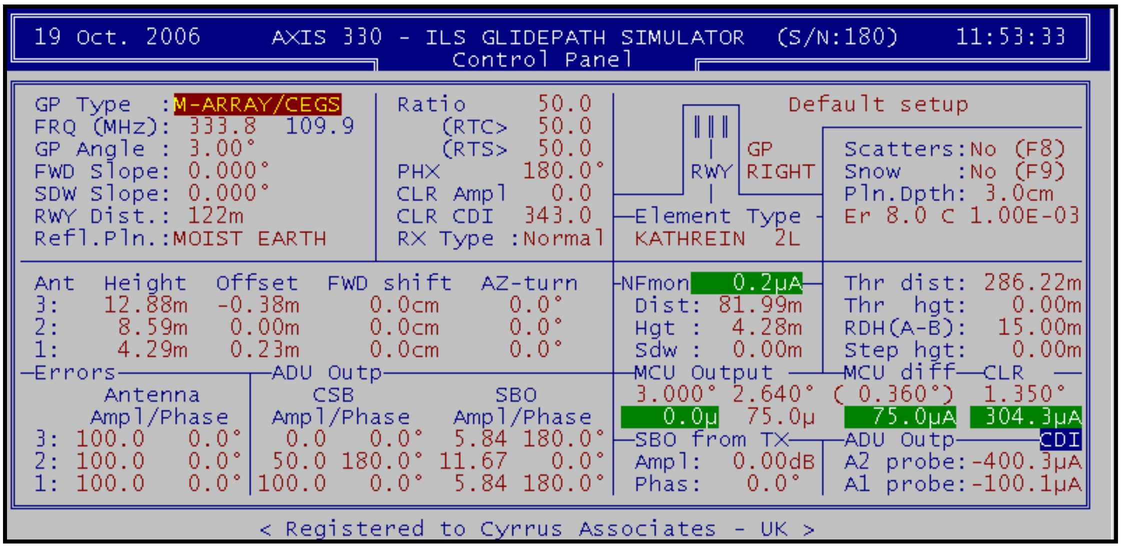


Figure 12. AXIS 330 main control panel – default setup

5.4.2 It is evident from the LVNL simulation that this was based on the default parameter set with the exception of the glidepath frequency (channel). There has been no attempt to input the correct antenna position data in terms of backset and offset distances. This introduces some negative differences to the results compared to a more accurate model.

5.4.3 The default terrain values of zero for forward and sideways slope are probably accurate at Schiphol as the ground is very flat.

5.4.4 It was also noted that the ILS at Schiphol is a type that radiates a separate clearance signal which was switched off for the simulation. Investigations reveal that this makes no difference to the course structure, but does exaggerate the effects on the window, vertical trace, and lateral trace plots presented by LVNL. Whilst the changes are not great, the glidepath is not allowed to be used operationally with the clearance transmitter switched off; therefore the model is not accurately representing any potential effects on the ILS system.

5.4.5 One further area identified where the LVNL model is considered unrealistic is the choice of receiver damping factor used. All ILS receivers incorporate damping of the deviation output to prevent noise affecting the aircraft flight control systems. The receiver damping factor is stated in Attachment C to part I of ICAO Annex 10[1] as a time constant which is a function of aircraft approach speed. The implementation of the receiver filter in AXIS 330 is quoted in radians per second (rad/s). The LVNL simulation utilised a default receiver damping filter coefficient of 5 rad/s, which is much less than the ICAO recommendation which is approximately 2 rad/s. [4] As a consequence, the LVNL model predicts beam bend amplitudes which are greater than would be seen by users. By comparing the results of the two filters, the LVNL result is around 7% higher than would typically be seen by users. See Figures 9 and 13.

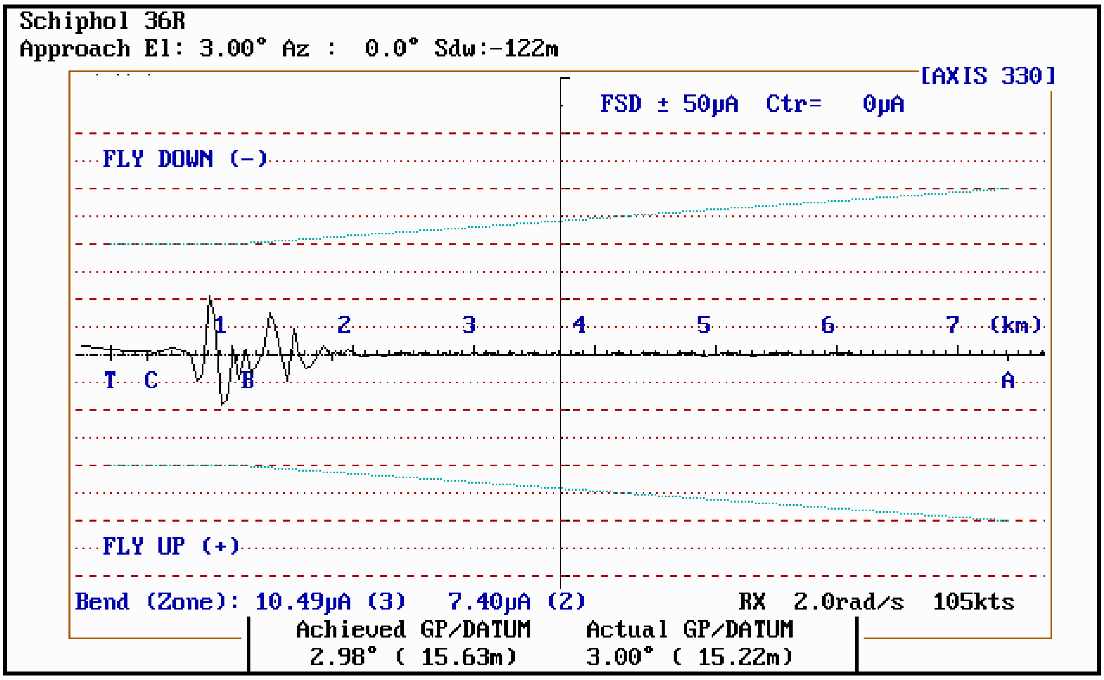


Figure 13. LVNL simulation with 2 Rad/s filtering.

5.5 Observations

5.5.1 Whilst it is convention to make an initial safeguarding assessment on a worst-case model, it is then normal practice to refine the model to determine what may be acceptable or to identify the major components of the development that contribute most to the degradation of the ILS signal. In this case, the decision seems to have been made purely on a worst-case scenario which was not representative of the building plans submitted.

5.5.2 The overall combination of using default AXIS parameters, no clearance signal, and inappropriate filter coefficients has served to exaggerate the predicted effects on the glidepath.

5.5.3 It was stated by LVNL that the static error budget is 14.14µA. If the existing 56% (7.72µA) is added to the LVNL model as a vector quantity by Root Sum Squares method, then the total static error would be $\sqrt{(7.72^2 + 11.21^2)}$=13.61µA, which is less than the total stated static error budget of 14.14µA. On this basis, the error predicted by the LVNL simulation does not exceed the budget.

5.6 Alternative Worst-Case Model

5.6.1 As stated, the building model used for the simulation is considered to be neither representative nor worst-case. To better assess the worst-case scenario, the simulation was configured with more refined glidepath data and a model that is considered to be a better representation of worst-case. Details of this further simulation are given for comparison.

5.6.2 The simulation was configured as per Figure 14. The model of the building represented as scattering objects is shown in Figure 15.

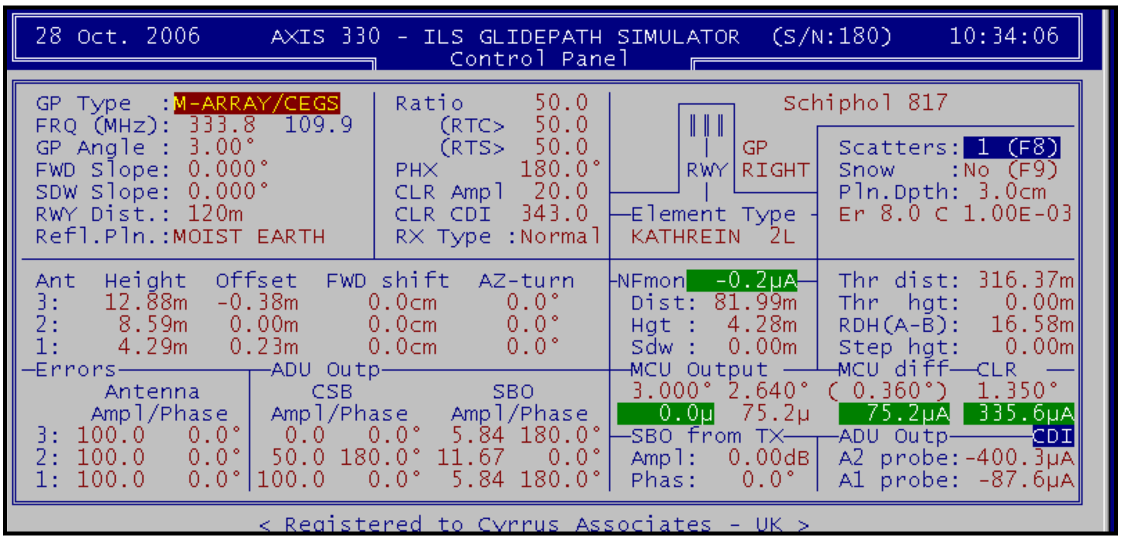


Figure 14. Schiphol 36R Glidepath Configuration

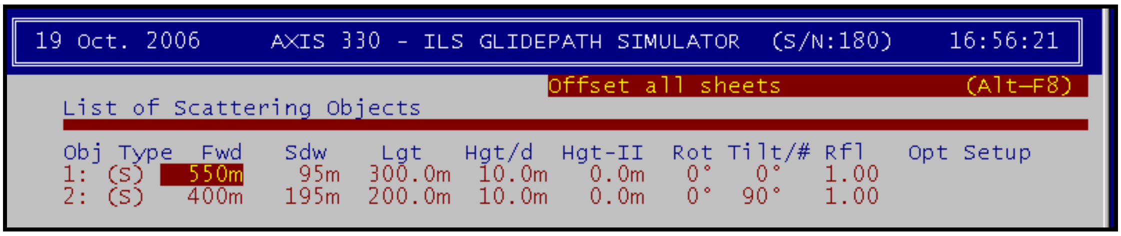


Figure 15. Worst-Case Scattering Objects

5.6.3 The scattering objects represent the faces of a 10m tall building which are illuminated by the ILS glidepath. The building is placed at the closest edge of the Groenenbergterrein and parallel to the runway. These objects are depicted in magenta in Figure 16

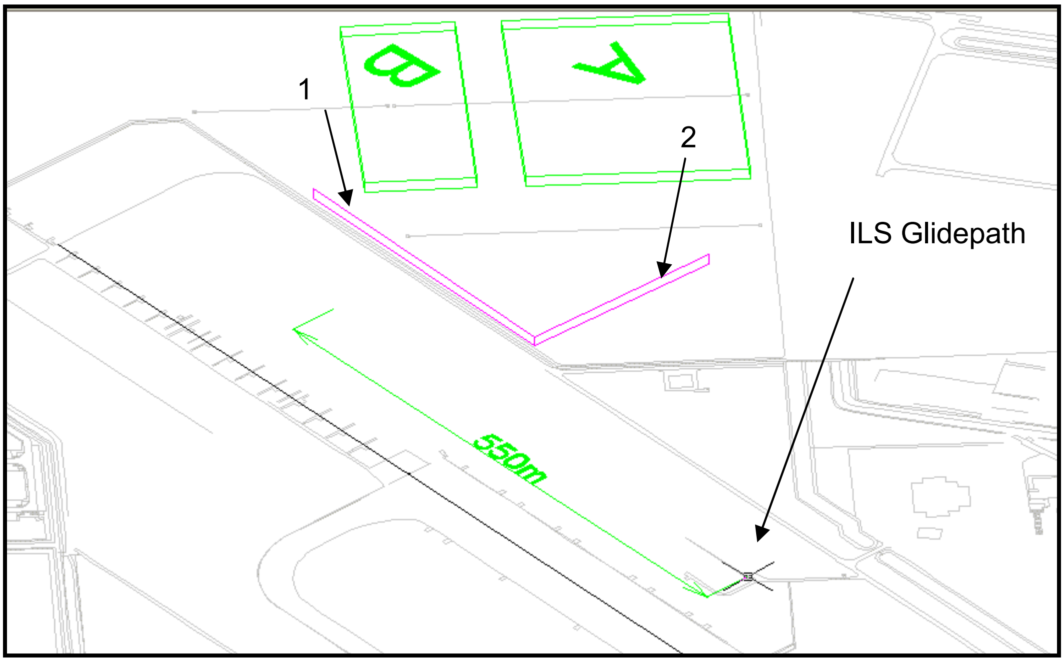


Figure 16. Drawing of Worst Case Model – Objects shown in magenta

5.6.4 The result of moving the side of the building much closer to the boundary of the Groenenbergterrein is shown in Figure 17

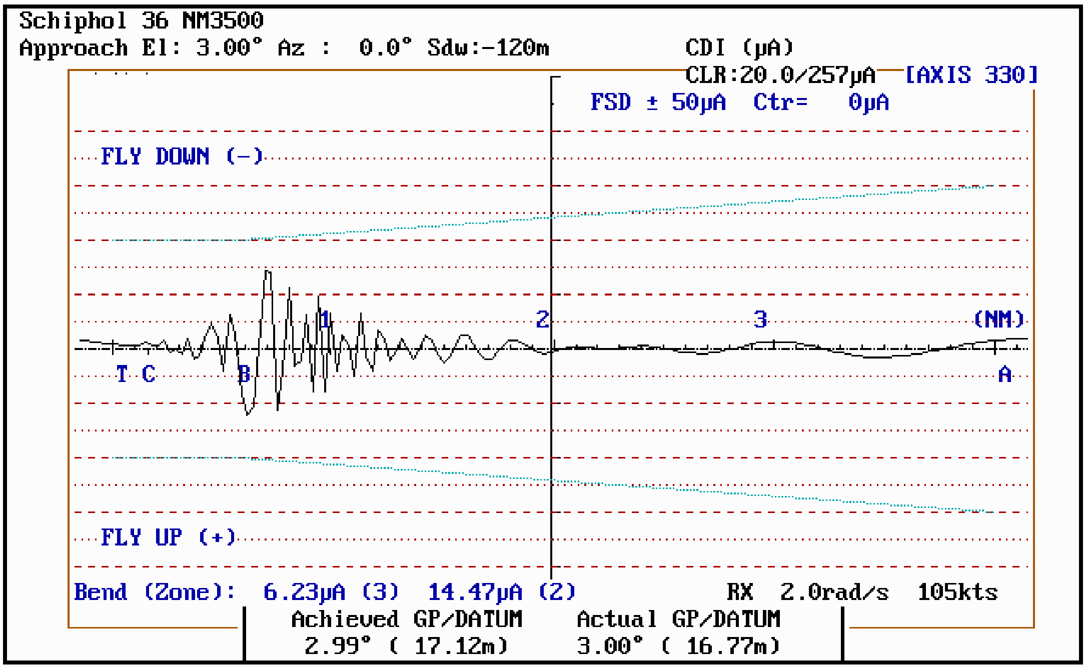


Figure 17. Result of modified worst-case model.

5.6.5 It can be seen by comparison with Figure 13 that buildings closer to the boundary of the Groenenbergterrein have a greater effect than that modelled by LVNL. In this instance, the refined worst-case model shows greater degradation of the ILS than was predicted by the LVNL assessment. This raises some concerns in that the LVNL worst-case model did not sufficiently identify the degree of degradation on the ILS which could have subsequent safety implications to users of the ILS facility. It should be noted that this worst-case scenario is not intended to represent the Chipshol plan, but rather to determine the maximum disturbance that development on the GBT could cause.

5.6.6 It should be noted that this is only an attempt to illustrate a realistic worst-case scenario. Further refinement of the model to demonstrate the effect of the planned development and of areas A and B on the Groenenbergterrein is explored in Section 7.

5.6.7 A point to consider is the modelling dynamics of AXIS 330 for a rectangular sheet object. AXIS calculates the reflection and diffraction as if it emanated from the centre of the sheet. This gives very accurate results if the object is 'in the far field', that is if the distance from the antenna is much greater than the dimensions of the object. In this instance, the model dimensions and distances are very similar. As a consequence of this, the result will consist of a large effect over a small area, whereas in reality, the effect will be smaller but will affect a larger portion of the glidepath beam. A large object close to the antenna can be more accurately modelled by dividing the object into an equivalent number of smaller sheets. Generally, for worst-case safeguarding, it is acceptable to use a single large sheet as this will define the maximum possible disturbance. On this basis, some margin of safety/comfort is built in to the worst case model as the actual maximum disturbance should be less than predicted.

5.7 Conclusions

5.7.1 The only conclusion that can be reached from the LVNL model is that the construction of a building of the dimensions modelled (i.e. a metal clad building 300m long and 10m high, parallel to the runway and in the location stated) would lead to a disturbance of 11.21μA in Zone 3. The acceptability of this figure is subject to analysis of the existing error budget. It is not possible to determine from the data presented the acceptability or otherwise of any other building development on the Groenenbergterrein and certainly not applicable to development of areas A and B.

5.7.2 The simulation does not in any way justify any building height restrictions.

5.7.3 The review of the LVNL modelling leads to the conclusion that the simulation was poorly executed. The building model used was neither representative nor worst-case, and the configuration of the simulation was inexact. Furthermore, no attempt appears to have been made to refine the initial model to determine acceptable building dimensions for the Groenenbergterrein.

5.7.4 The configuration of the simulation resulted in an exaggeration of the predicted effects.

5.7.5 Technically, the results of the LVNL model did not exceed the remaining error budget if the simulation and existing static error budget are added by Root Sum Squares method.

5.7.6 On the evidence provided of the ILS simulation and subsequent planning objections, the conclusions and decisions made by LVNL on the Groenenbergterrein were based on a simulation that was inaccurate and unrepresentative. Furthermore, the simulation does not support the conclusions reached by LVNL.

5.7.7 Nonetheless, the errors made resulted in an underestimation of the worst-case effects, and presented a false premise on which to base planning decisions.

6 NLR Assessment NLR-CR-2005-113

6.1 Background

6.1.1 NLR carried out an assessment of the proposed design GBT813bl01 and reviewed LVNL data to assess the concerns raised by LVNL as modelling had determined excessive effects on ILS glidepath course structure.

6.2 Assessment

6.2.1 It is not possible to assess the validity of the simulation as the data used has not been made available. The printouts from LVNL contained sufficient data to reverse-engineer the simulation. Unfortunately, the NLR report only contains the output of the model.

6.2.2 The major source of interference was established to be the truck parking to the North of the GBT site. The objects modelled are shown in Figure 20 which formed Appendix A to the NLR report.

6.2.3 The following observations are made based on Figure 20: The major contribution to glidepath bends was determined to come from the truck parking (A' and B' in Figure 20). From interpretation of the drawing, there is a 3.5m earth embankment between the majority of the truck park and the ILS (Figure 19) which serves to provide screening of the trucks and part of the building. It is not clear if this was allowed for in the modelling.

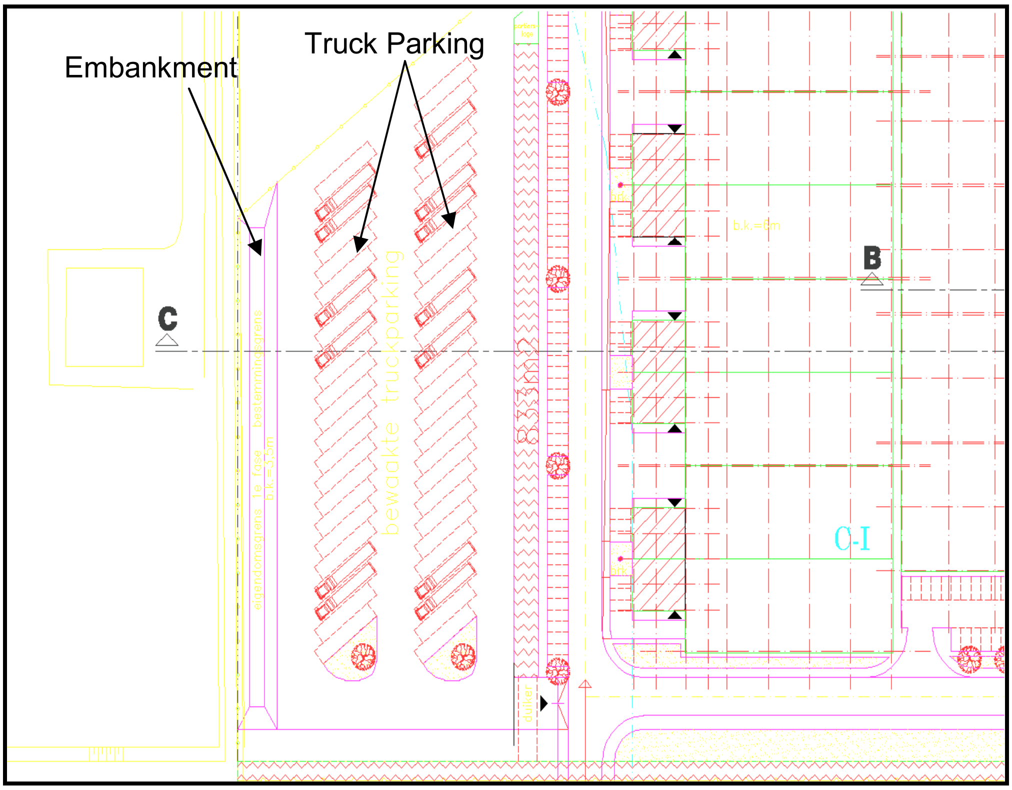


Figure 18. GBT813bl01 Truck Parking

6.2.4 Figure 19 shows a cross section of Figure 18 at ‘C’.

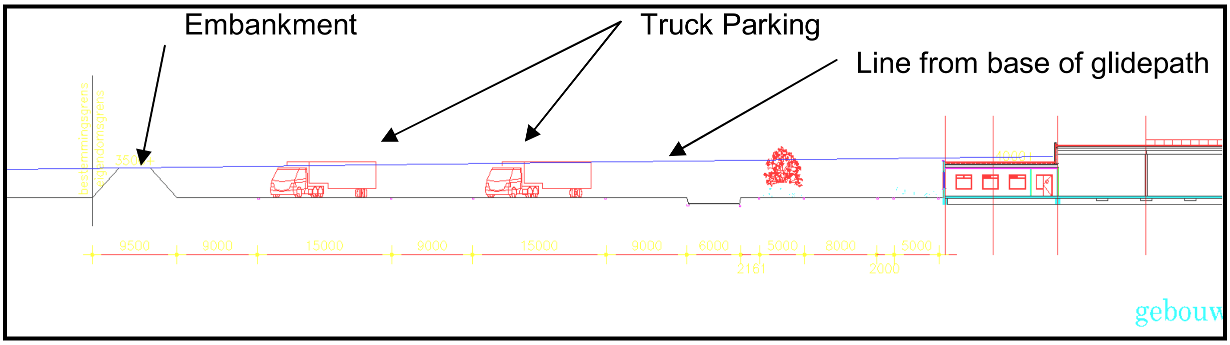


Figure 19. Cross Section of truck parking

6.2.5 As Figure 19 shows, the embankment provides screening of the trucks and part of the building, yet it is not clear if this was accounted for in the model.

6.2.6 Using a generic model, the main contribution from the trucks comes from B’ in Figure 20, which is nearly parallel to the runway. If this was the case, why was the orientation of the truck parking not altered to reduce this?

6.2.7 As stated in section 3.6, only those aspects of the building illuminated by the ILS signal are modelled. Items B, C, D, F, G and I in Figure 20 do not appear to be directly illuminated and yet are identified on the plan.

6.2.8 It was noted that the glidepath clearance ddm was set to 257µA which is typical of a Thomson-CSF 381 system. The Normarc NM3500 normally operates with a clearance ddm of 343µA. It is thought that this difference is unlikely to make any change to the findings in this instance.

6.2.9 It is considered that the treatment of remaining error budgets was incorrectly assessed. Of the 14.14µA total static error budget, LVNL had stated that 54.6% (7.72µA) was already used (from *NLR report NLR-CR-2006-185*). The remainder has been assessed by LVNL and NLR as 14.14µA-7.72µA=6.42µA. Bends are a result of the vector addition of multipath components; it is normal practice to add vector quantities by Root Sum Squares method, not by straight arithmetic addition. In this case the remaining budget is 11.84µA not 6.42µA. A full explanation is given at Section 7.10.

6.2.10 It was noted from the graphical presentation of the simulation results in the NLR report that a receiver damping factor of 5rad/s was used rather than a more realistic 2rad/s (see Section 5.4 for further details). As a consequence, the predicted results are exaggerated.

6.2.11 It was further noted that the graphical presentations were on an expanded scale of ±25µA. Visually, this exaggerates the effect when compared to the 1998 LVNL report which used a scaling of ±50µA.

6.3 Conclusions

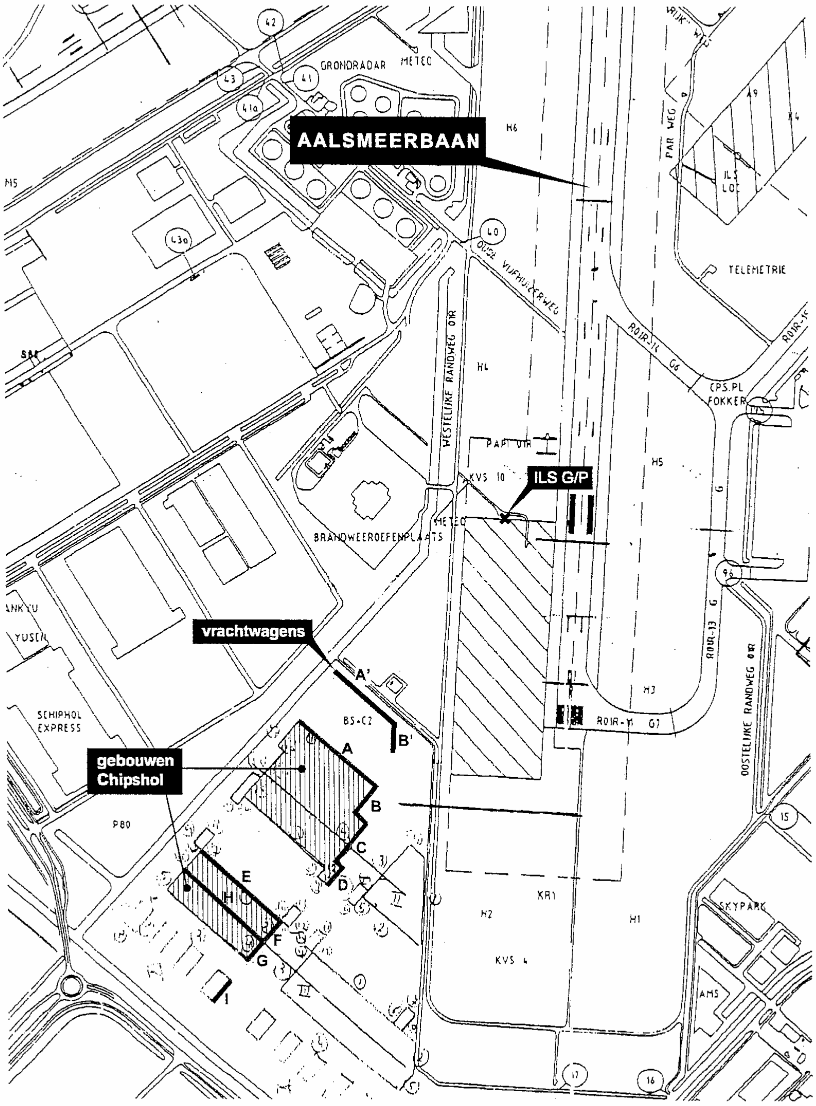
6.3.1 The modelling on which the decisions were made is not available for critique. The NLR report is however quite comprehensive and identifies that the only issue outstanding by LVNL modelling is the truck parking. The truck parking was removed from latter plans and replaced by a water feature. The issue of the truck parking is addressed further in Section 7.

6.3.2 It is considered that the available error budget was incorrectly assessed. In this case, the statements about the GBT development, or more precisely the truck parking, exceeding the available error budget are also incorrect.

6.3.3 The assessment of disturbance caused by the truck parking was made using an unrepresentative receiver damping factor. Use of a more representative figure would have resulted in a lower disturbance figure.

6.3.4 It was noted that NLR report NLR-CLR-2006-185 which assesses some of the earlier issues of ILS glidepath disturbance refers several times to AXIS 110. The AXIS glidepath simulation tool is AXIS 330. AXIS 110 is the ILS localiser simulation tool.

Appendix A Figuren



Figuur 1 Situatieschets van toekomstige gebouwen op Groenenberg terrein volgens bestektekening V.2002W813bl01 (d.d. 29-10-2002), voor kavels I en IV, inclusief parkeerplaats voor vrachtwagens; de groene lijnen representeren de gevels van de gebouwen, de rode lijnen representeren artificiële vlakken van geparkeerde vrachtwagens.

Figure 20. NLR report Appendix A

7 Safeguarding Assessment - Cyrrus

7.1 General

7.1.1 This section addresses a safeguarding assessment of the GBT as proposed in drawing GBT813bl01 of October 29th 2002 carried out by Cyrrus Associates Ltd in accordance with existing industry best practice.

7.1.2 The intention is to provide a logical and independent safeguarding assessment of the GBT development from which any remaining questions may be answered.

7.2 Physical Safeguarding

7.2.1 The method of assessing the significance of any existing or proposed object within the aerodrome boundary or the vicinity of the aerodrome is to establish defined obstacle limitation surfaces (OLS) particular to a runway and its intended use. The purpose of the OLS are to define the volume of airspace that should be ideally kept free from obstacles to minimise the danger presented by the obstacles to an aircraft departing from or arriving at the airport. These surfaces are defined in ICAO Annex 14 [2].

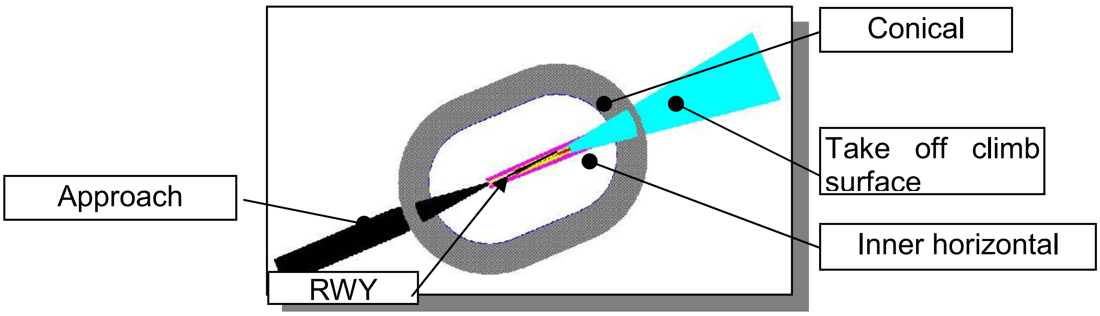


Figure 21. Example of the Obstacle Limitation Surfaces

7.2.2 This is depicted in a 3D presentation at Figure 22.

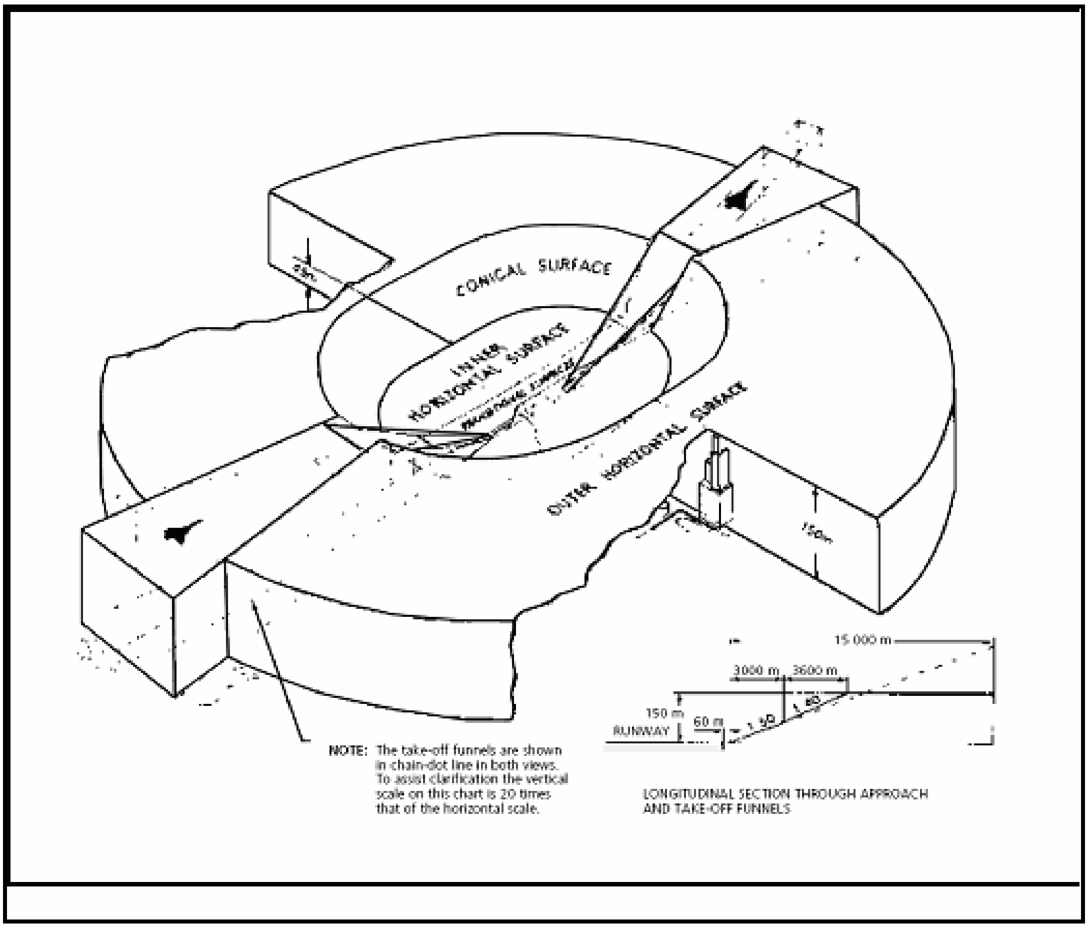


Figure 22. 3D representation of OLS.

7.2.3 To assess any possible penetration of the surfaces, a digital terrain model is constructed, and the surfaces are overlaid using bespoke modelling software. This allows the assessment of maximum building heights in the development area.

7.2.4 An overview of the runway OLS are depicted at Figures 23-25.

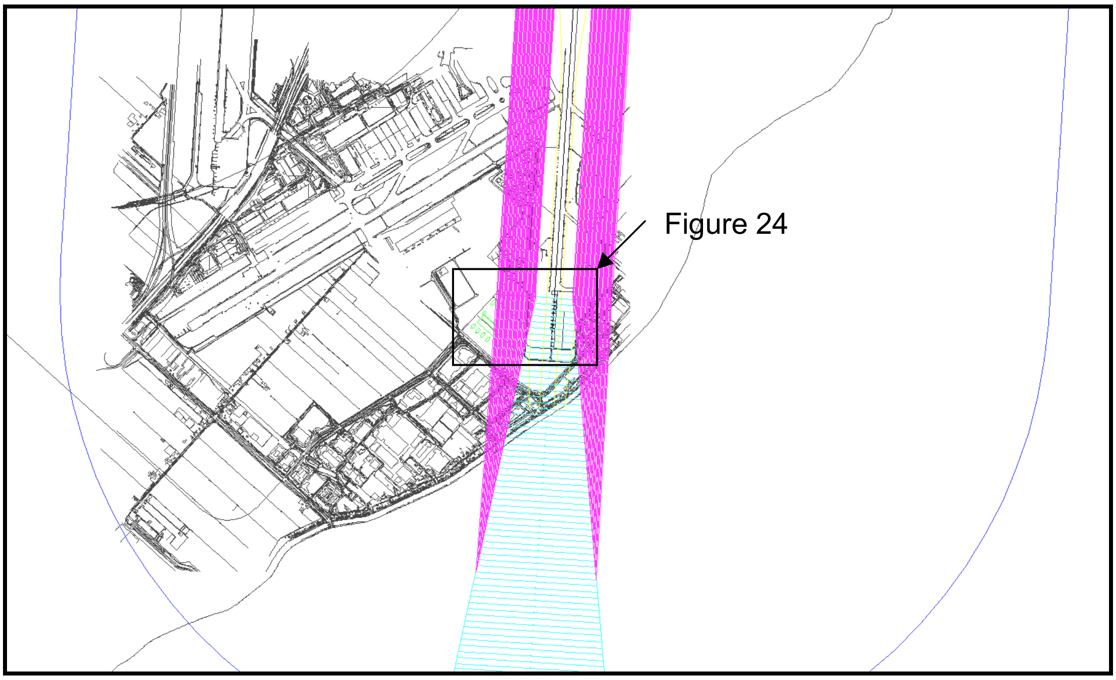


Figure 23. Obstacle limitation surfaces around Aalsmeer Runway

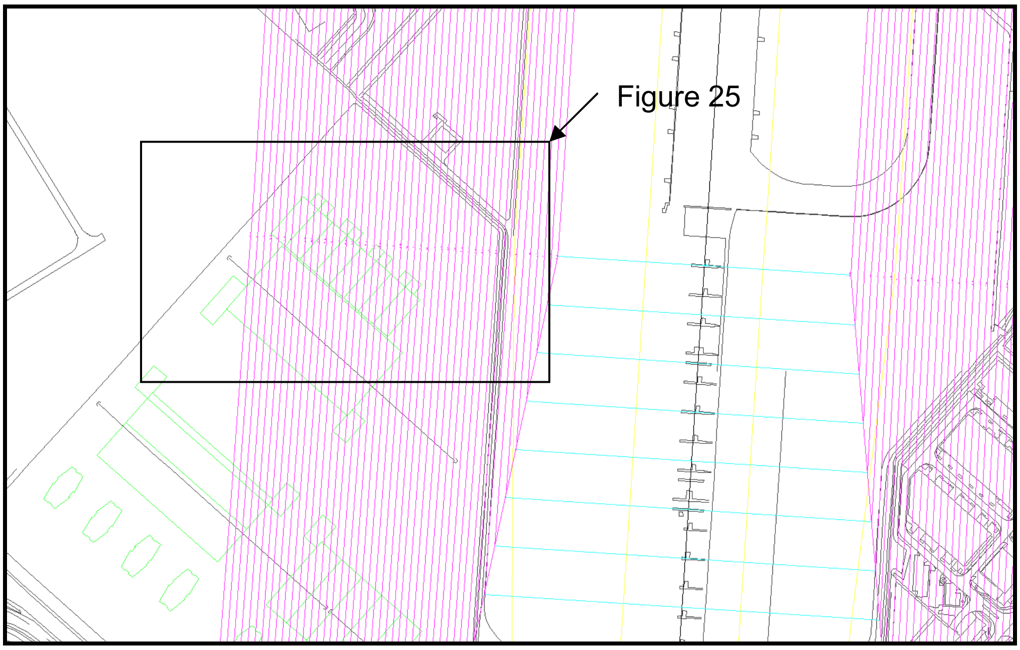


Figure 24. Obstacle Limitation Surfaces around Aalsmeer Runway - Detail

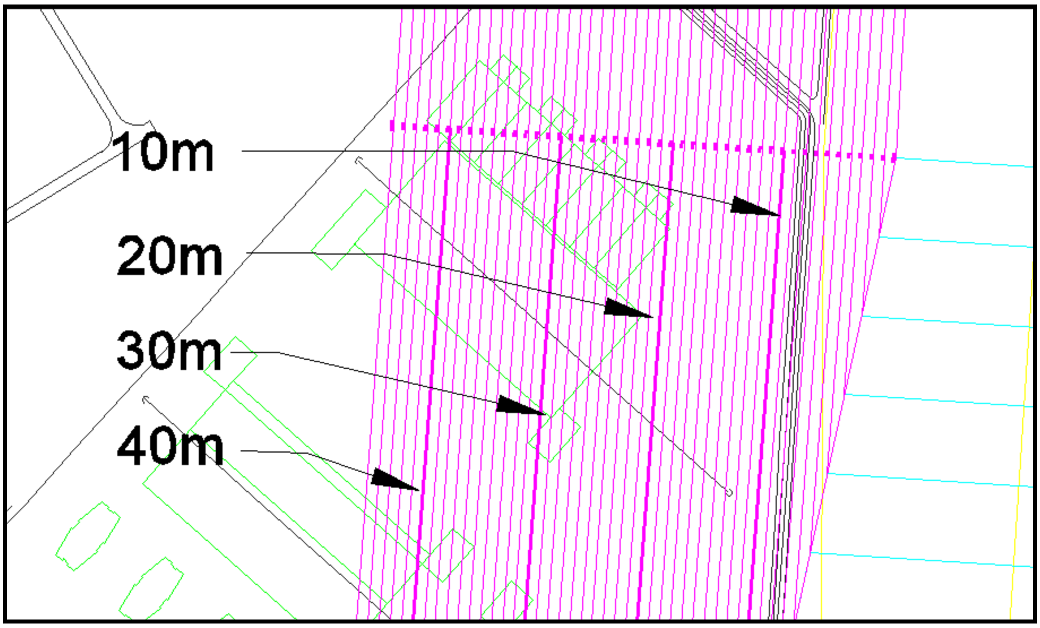


Figure 25. Obstacle Limitation Surfaces at GBT - Detail

7.2.5 The Obstacle Limitation Surfaces assessment shows that the maximum building height at the edge of the GBT closest to the runway is 9m above the runway threshold level. This increases to 45m above the runway threshold level at the leftmost magenta line in Figure 24. Outside of the magenta lines, the maximum building height remains at 45m above runway threshold level. Buildings of up to 15m above runway threshold level may be located no closer than 50m to the eastern boundary of the GBT.

7.2.6 The planned development of the GBT remains below the prescribed Obstacle Limitation Surfaces and does not pose a physical obstacle to air navigation.

7.3 ILS Safeguarding

7.3.1 It has already been established that the GBT development falls within the safeguarded area of the ILS glidepath and localiser for runway 36R. LVNL has not raised any concerns over the impact of the GBT development on Localiser performance. This investigation will therefore concentrate on the ILS Glidepath issues both for the latest planned development and the original Circle Freight proposal. Worst-case has already been considered in section 5. At this stage a more refined model is being sought.

7.4 ILS General

7.4.1 The ILS specification in 1998 was as follows:

- Glidepath Equipment: Normarc 3500
- Glidepath Antenna Configuration: M-Array (CEGS)
- Glidepath Antenna type: Kathrien
- Antenna distribution: Normal (50/180)

- Antenna backset from threshold: 316.39m
- Antenna offset from runway centreline: 119.88m
- Glidepath Frequency: 330.80MHz
- Category of operation Cat III
- Terrain forward slope 0.00°
- Terrain sideways slope 0.00°

7.4.2 The ILS has subsequently been replaced with a new system; however, the operating parameters remain unchanged.

7.4.3 The parameters above are entered into AXIS 330 simulation software as an initial configuration. The configuration is shown at Figure 26.

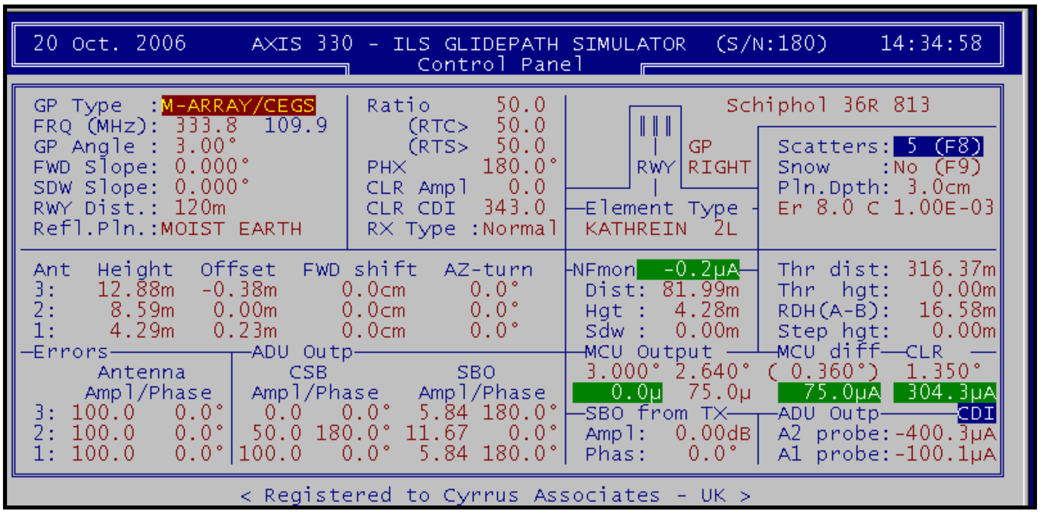


Figure 26. Glidepath simulation Configuration

7.5 GBT813bl01 - 2002

7.5.1 The main aspects of the development are identified from the site drawings. Only those static objects directly illuminated by the ILS glidepath are considered. The truck parking will be considered later.

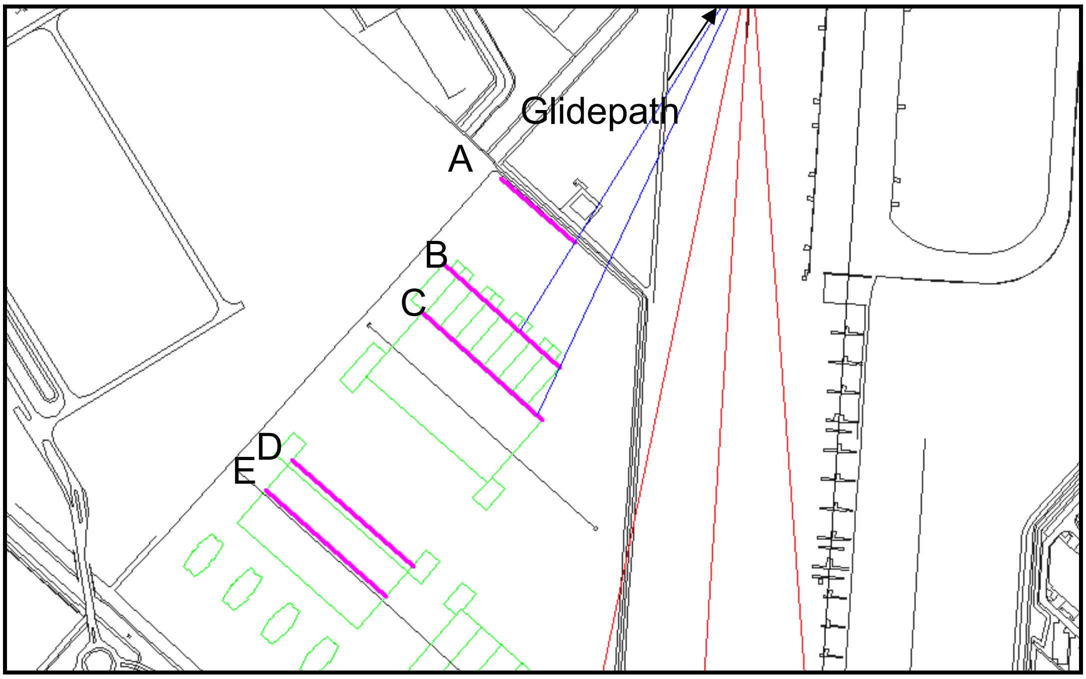


Figure 27. Location of scatter objects

7.5.2 In Figure 27, A is the embankment, and B-E are the faces of the buildings illuminated by the glidepath. Detail is shown in Figures 28-29.

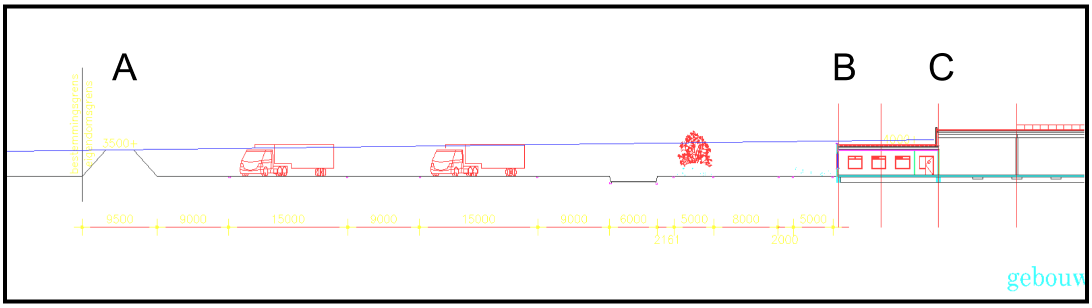
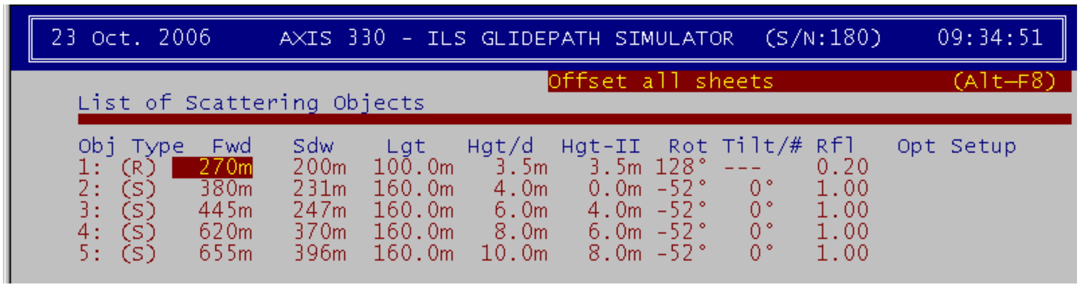


Figure 28. Cross-section of GBT development 1.

Figure 29. Cross-section of GBT development 2.

7.5.3 The scatter objects identified above are entered into the model as shown in Figure 30. All of the building components are entered as smooth metal plates and the embankment given a reflection coefficient of 0.2 in order to represent worst-case. Only the visible parts of each face are entered, although initially, face B is entered in its entirety even though it is approximately 60% screened by embankment A.



23 Oct. 2006 AXIS 330 - ILS GLIDEPATH SIMULATOR (S/N:180) 09:34:51

Offset all sheets (Alt-F8)

List of Scattering Objects

Obj	Type	Fwd	Sdw	Lgt	Hgt/d	Hgt-II	Rot	Tilt/#	Rfl	Opt	Setup
1:	(R)	270m	200m	100.0m	3.5m	3.5m	128°	---	0.20		
2:	(S)	380m	231m	160.0m	4.0m	0.0m	-52°	0°	1.00		
3:	(S)	445m	247m	160.0m	6.0m	4.0m	-52°	0°	1.00		
4:	(S)	620m	370m	160.0m	8.0m	6.0m	-52°	0°	1.00		
5:	(S)	655m	396m	160.0m	10.0m	8.0m	-52°	0°	1.00		

Figure 30. Scattering Objects

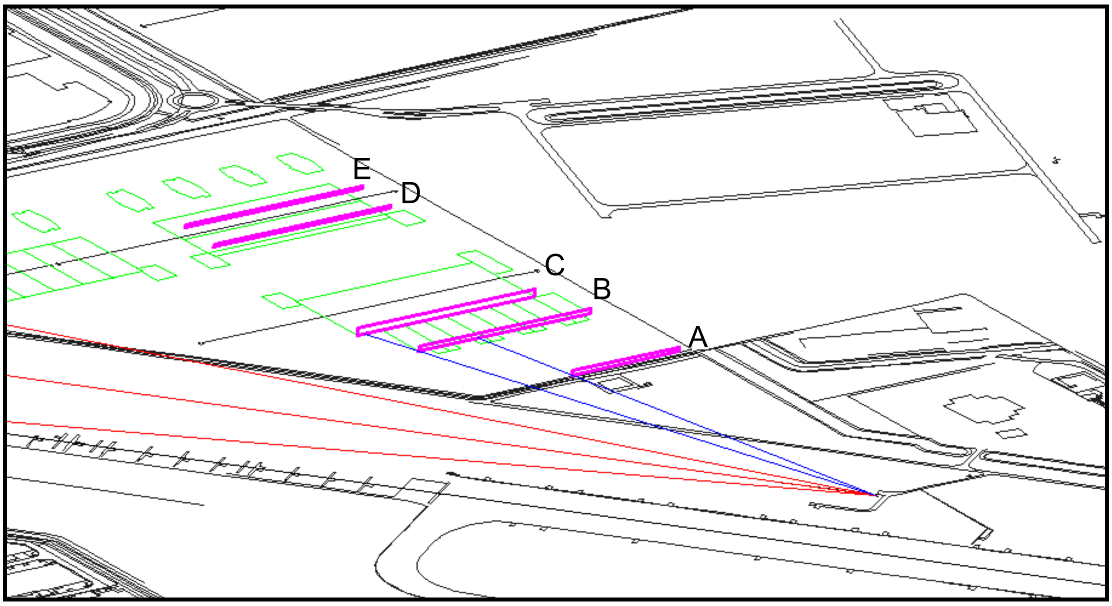


Figure 31. View of Scatter Objects

7.5.4 The objects A-E in Figure 31 are Scatter Objects 1-5 respectively in the model Figure 30. The embankment is 3.5m high. Face B is modelled as a 4m high smooth plate. Only the visible portions of faces C-E are modelled. In this case they are modelled as 2m high plates at the appropriate elevations.

7.5.5 Initially, the model is run without any scattering objects in order to establish a baseline. The resultant Approach Course Structure and Window Overview (a measure of off course disturbance) are shown in Figures 32-33 as a baseline reference.

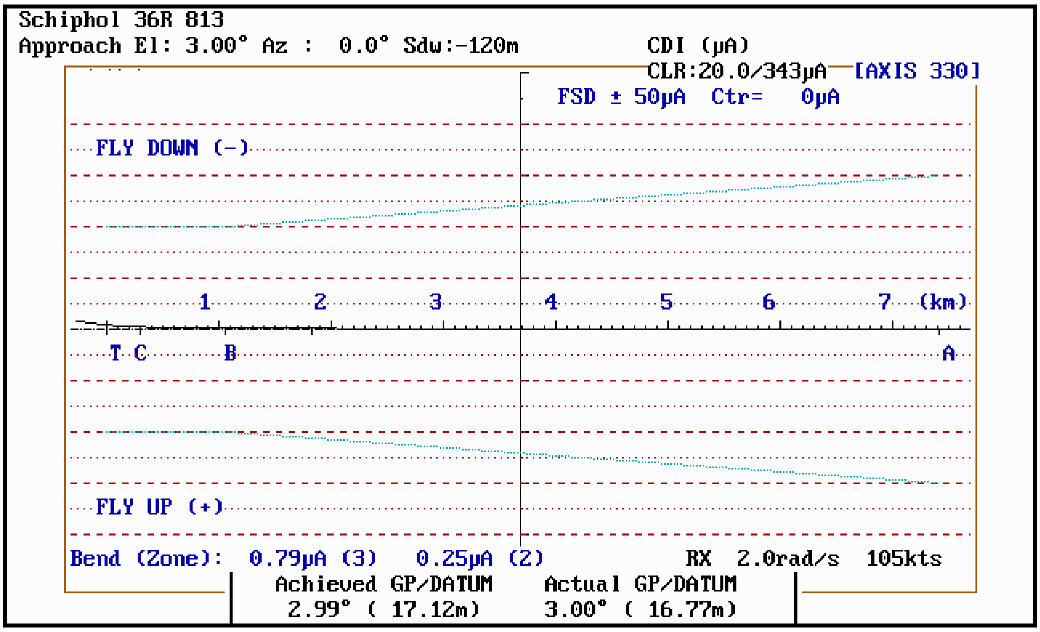


Figure 32. Approach on path – No scatter objects

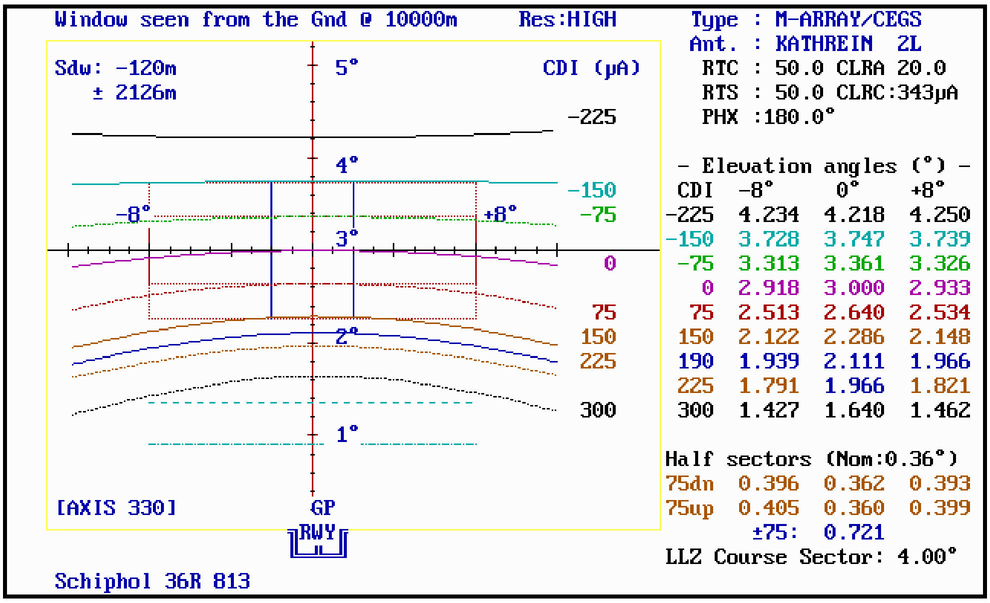


Figure 33. Window Overview – No scatter objects.

7.5.6 Having established a baseline, the next stage is to run the model again but with all of the scattering objects active as per Figure 30. The results are shown in Figures 34-35.

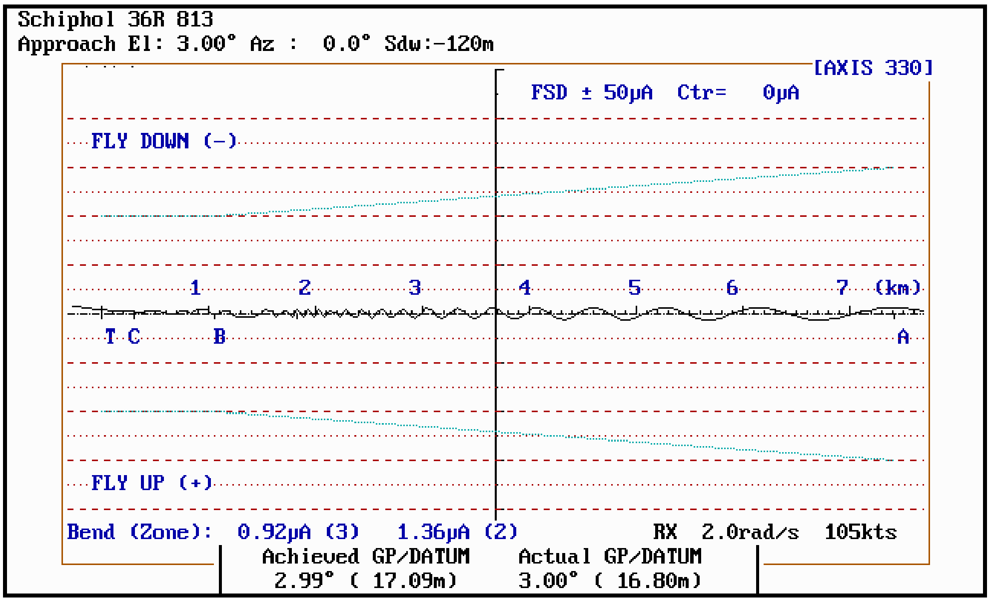


Figure 34. Approach on path – Buildings modelled as per GBT813bl01.

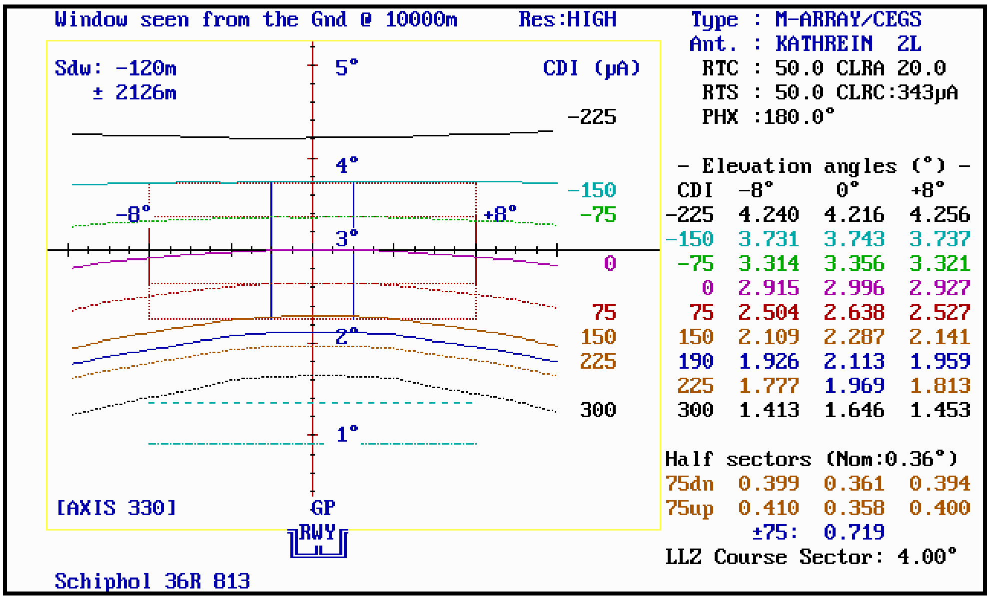


Figure 35. Window Overview – Buildings modelled as per GBT813bl01.

7.5.7 It is evident that the buildings as modelled contribute very little disturbance of the ILS glidepath. Normally at this point, each scatter object would be examined individually to establish the contribution from each component, but in this instance the effects are so small, it is not considered worthwhile.

7.5.8 For interest, it was decided to increase the height of building face B to 10m and consider this in isolation. (Faces C-E would be screened if B was 10m). The results are shown in Figures 36-37.

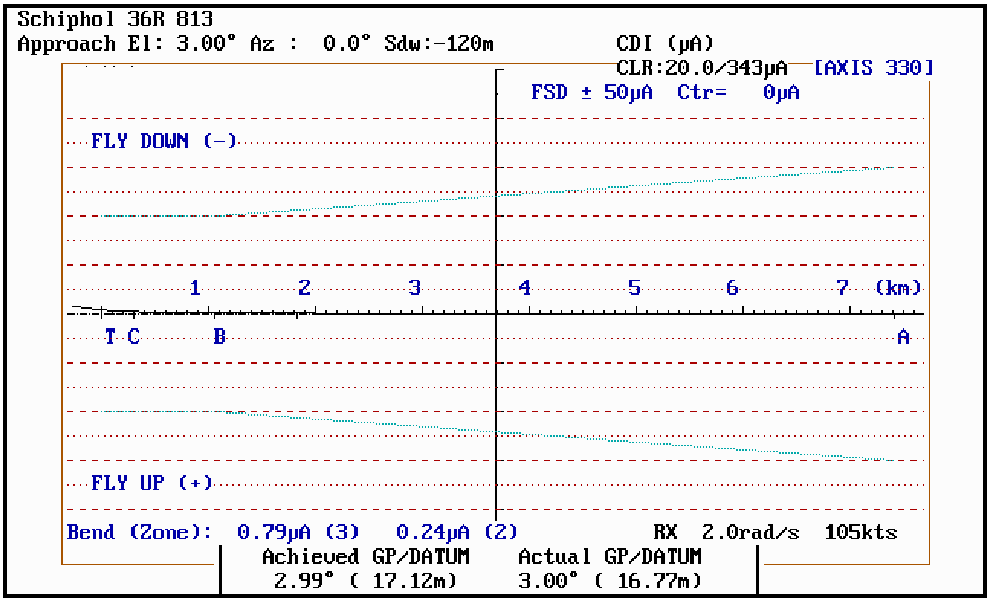


Figure 36. Approach on path – Face B at 10m

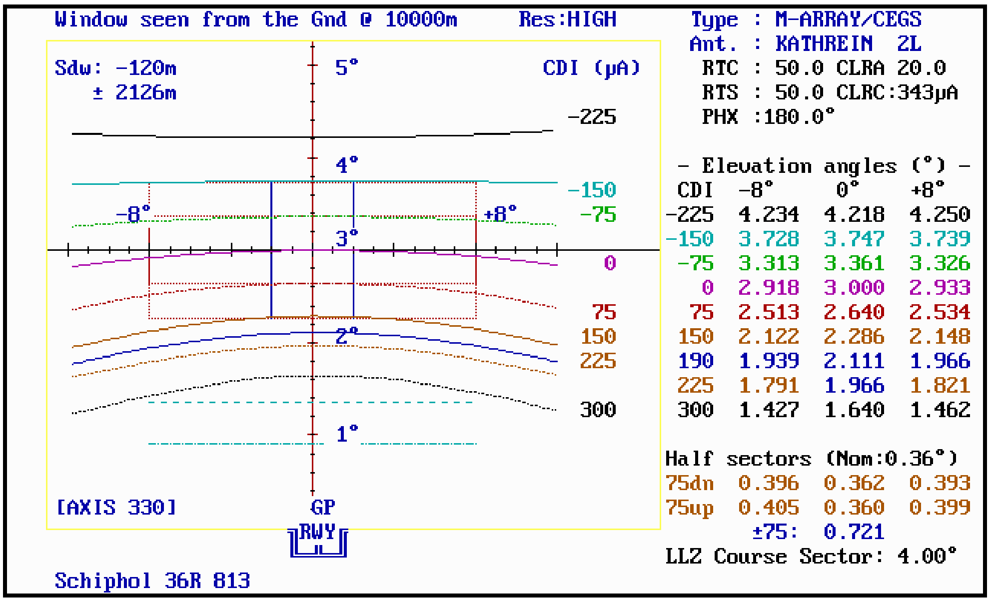


Figure 37. Window Overview – Face B at 10m.

7.5.9 With face B of the building raised to 10m, the effect on the ILS glidepath remains well within acceptable limits, and less than 10% of the LVNL static error budget. This number was surprisingly low, especially in Zone 2 (ILS Point A to ILS Point B). To establish the source of the distortions of the full model, the embankment was modelled in isolation.

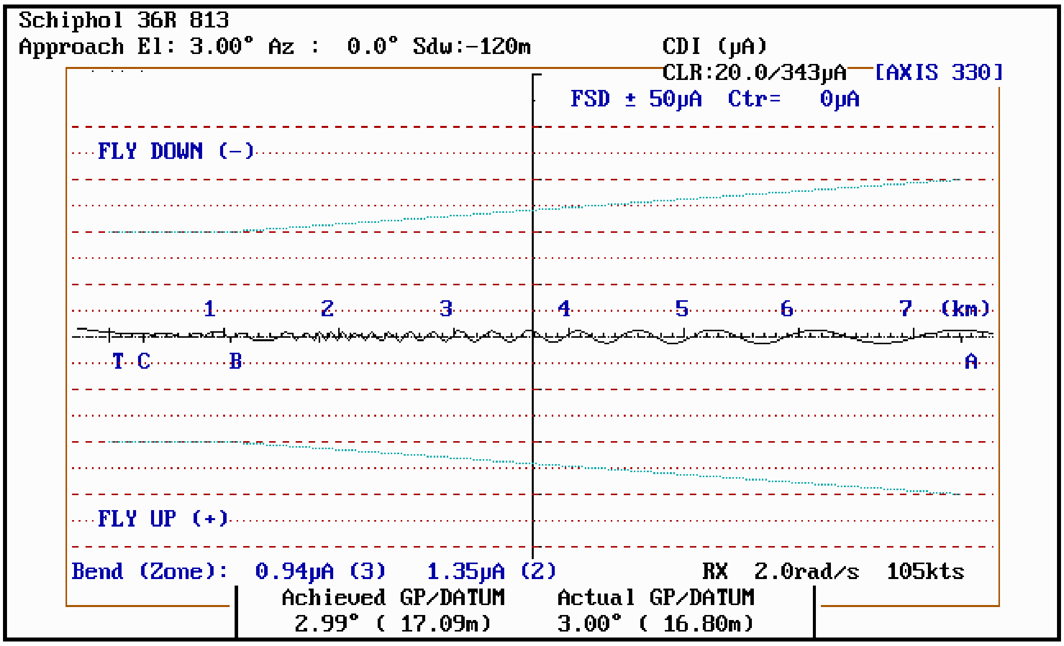


Figure 38. Approach on path – Embankment (ridge) only

7.5.10 It is evident that most of the course distortions emanate from the ridge. In actuality, the buildings would screen most of the ridge reflections from the aircraft; it would probably have a much lesser effect in real life.

7.5.11 As the building faces had so little effect, it was decided to experiment with the effect of screening the northern end of the development with a tall metal fence. A fence 180m long by 4.5m high was modelled at the northern GBT boundary in place of the embankment. This would serve to screen the truck park and most of the buildings.

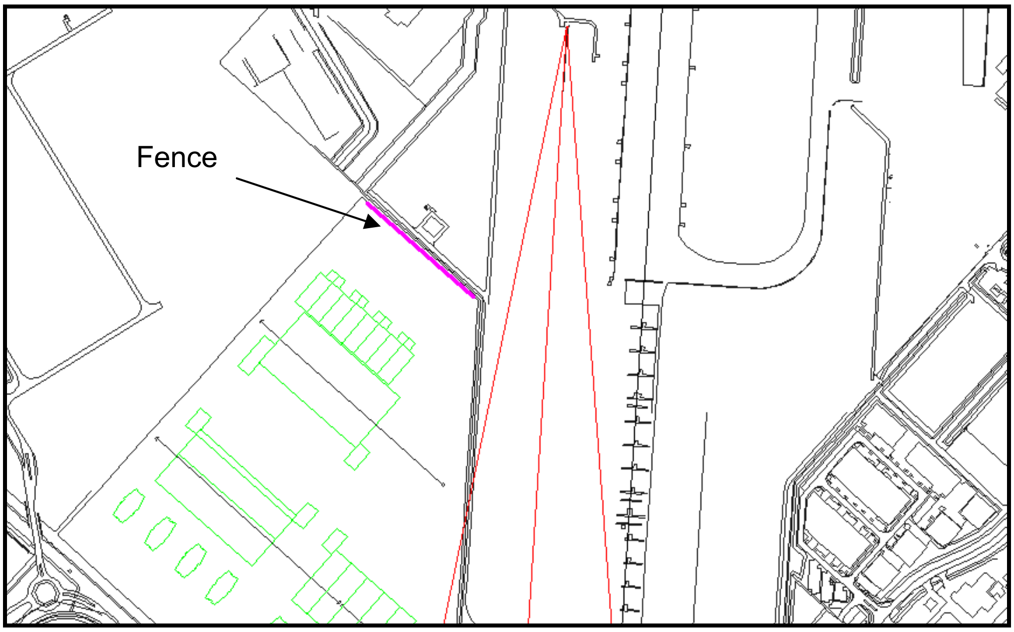
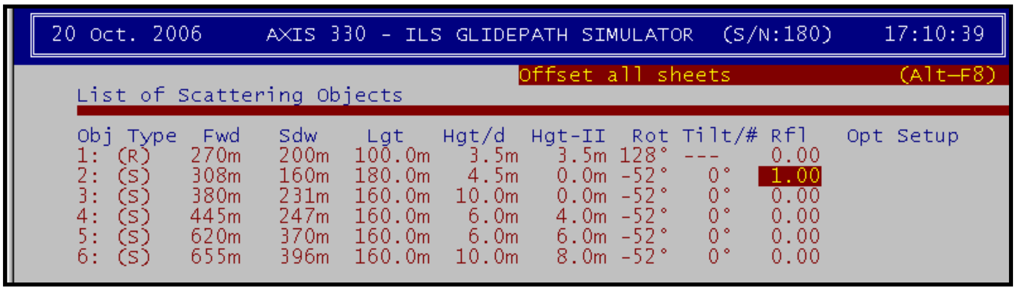


Figure 39. Screening fence shown in magenta.



20 Oct. 2006 AXIS 330 - ILS GLIDEPATH SIMULATOR (S/N:180) 17:10:39

Offset all sheets (Alt-F8)

List of Scattering Objects

Obj	Type	Fwd	Sdw	Lgt	Hgt/d	Hgt-II	Rot	Tilt/#	Rfl	Opt	Setup
1:	(R)	270m	200m	100.0m	3.5m	3.5m	128°	---	0.00		
2:	(S)	308m	160m	180.0m	4.5m	0.0m	-52°	0°	1.00		
3:	(S)	380m	231m	160.0m	10.0m	0.0m	-52°	0°	0.00		
4:	(S)	445m	247m	160.0m	6.0m	4.0m	-52°	0°	0.00		
5:	(S)	620m	370m	160.0m	6.0m	6.0m	-52°	0°	0.00		
6:	(S)	655m	396m	160.0m	10.0m	8.0m	-52°	0°	0.00		

Figure 40. 4.5m fence added at Object 2.

Other objects are set to a reflection coefficient of zero to eliminate them from calculations.

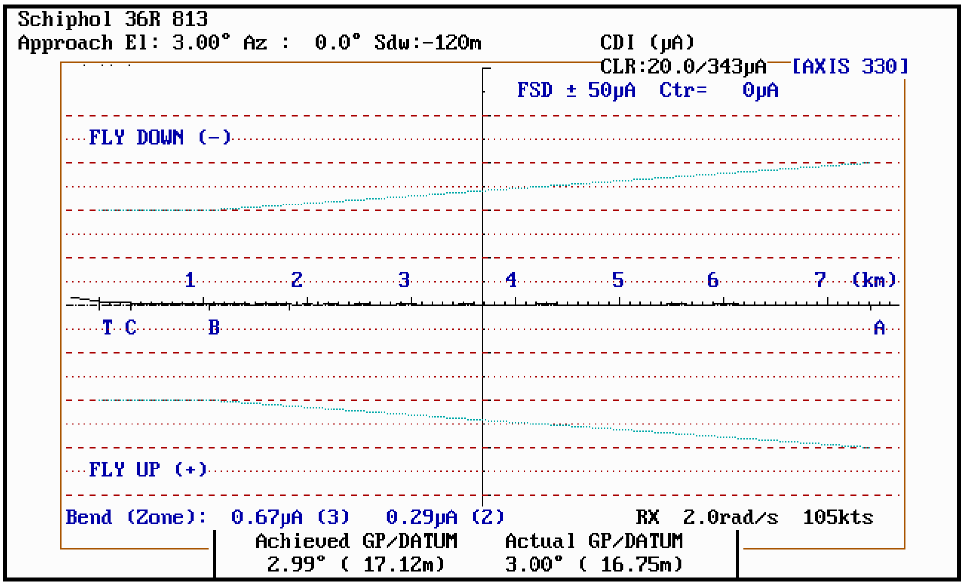


Figure 41. Approach on path – 4.5m screening fence

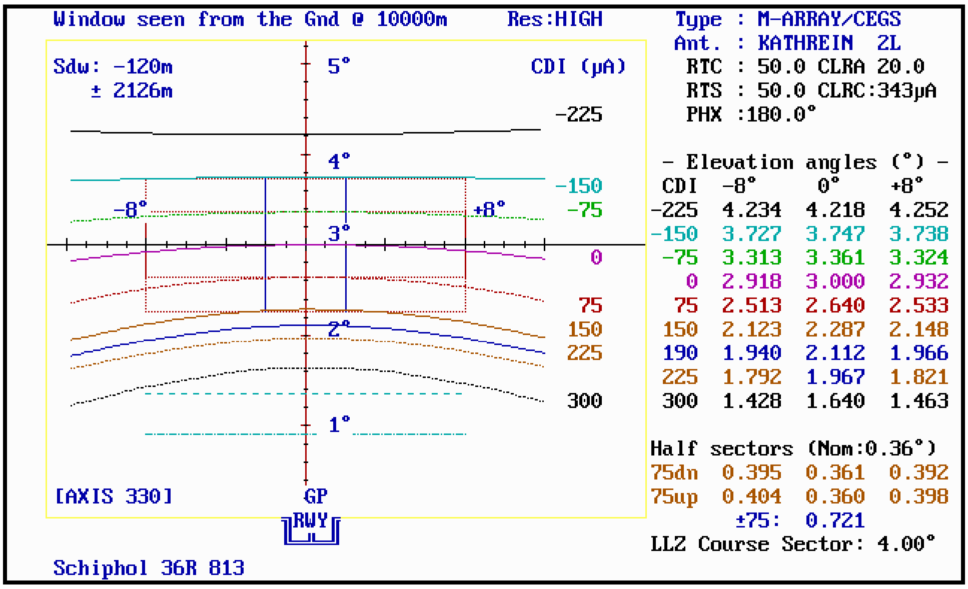


Figure 42. Window overview – 4.5m screening fence

7.5.12 It is interesting to note that the 4.5m high screening fence has almost no effect on the glidepath course structure or off course disturbance. This would also screen the truck parking area and a large proportion of the buildings.

7.5.13 The main contributors to ILS glidepath course disturbances are large surfaces that are aligned close to parallel with the runway. This topic is explored in greater detail at Annex A.

7.6 Circle Freight

Building proposal 1 of 1998 and building request 2 of 1999

7.6.1 Modelling has been carried out to address the specific issue of the proposed Circle Freight facility. This facility was assessed as per the drawings of December 1998.

7.6.2 The drawings illustrate two options for the Circle Freight facility, one is a triangular building located on the boundary of the GBT, and the second a rectangular building in what has become to be referred to as Area A. full details of the second option are shown in the drawings, however for completeness, both options are modelled. It should be noted that Chipshol submitted a proposal in 1999 only for the second rectangular building, referred to as Area A. The first triangular building located on the boundary of the GBT was not actually submitted, but has been investigated anyway.

7.6.3 The hardcopy drawings provided are of insufficient accuracy to determine absolute placement of the buildings, therefore some parameters of the buildings have been exaggerated within the model to provide a worst-case scenario.

Figure 43. Circle Freight Scenario 1.

7.6.4 The two faces of the building illuminated by the ILS glidepath, indicated by the thicker green lines in Figure 43, are entered into the model. The configuration is shown at Figure 44.

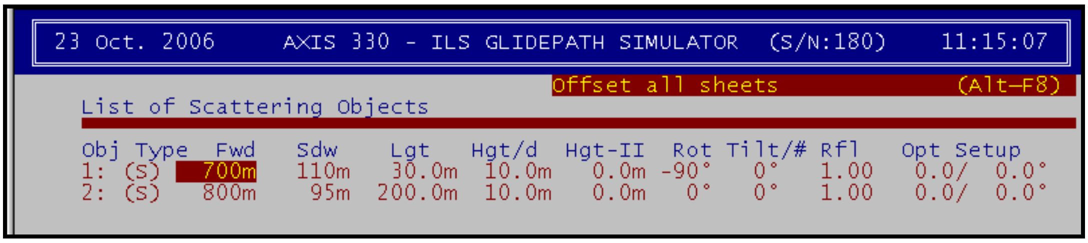


Figure 44. Circle Freight 1 Scatter Objects

7.6.5 The large face of the building is modelled as a 200m long by 10m high smooth metal sheet parallel to the runway. The smaller end face is modelled as a 30m long by 10m high smooth metal plate perpendicular to the runway. The large face is placed as close to the GBT boundary as possible. It is assumed that the building was intended to be 8m high, but this dimension has been increased to 10m to allow for uncertainty in positioning. The effects on the ILS glidepath are shown in Figures 45-46.

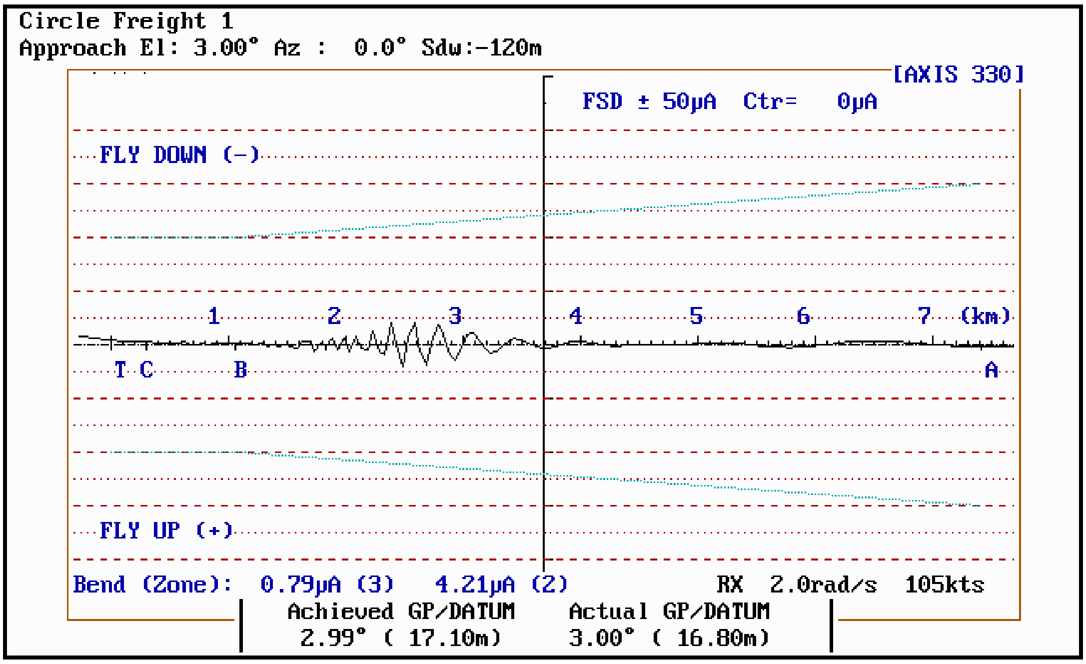


Figure 45. Circle Freight 1 – Glidepath Course Structure

7.6.6 The predicted course disturbance is well within LVNL limits

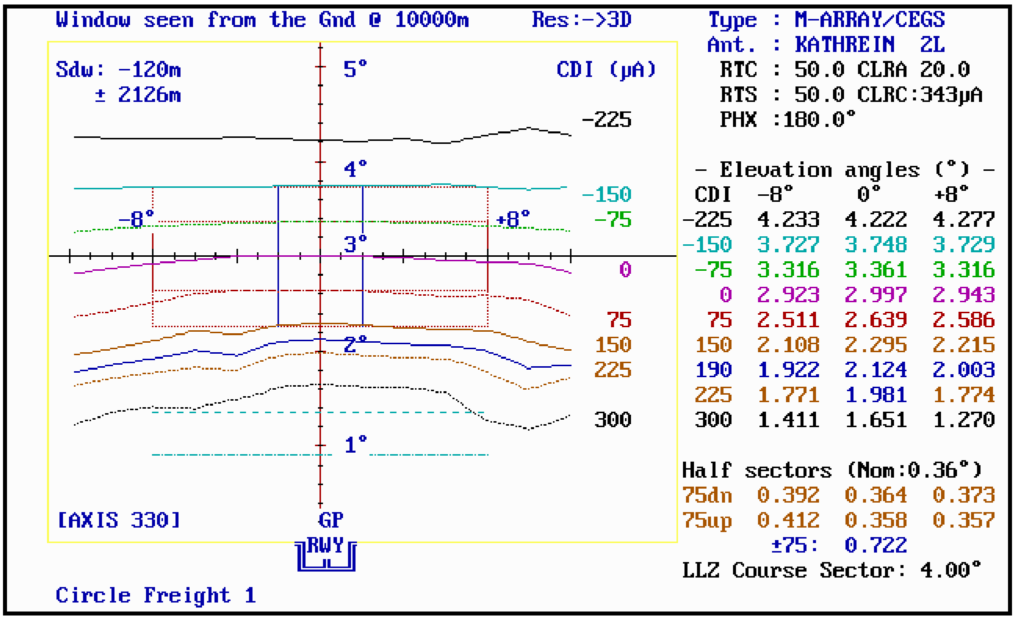


Figure 46. Circle Freight 1 – Window Overview

7.6.7 The window overview shows some disturbance to the pattern, especially to the West of the runway centreline. To put this into context, the glidepath clearance signal, 8° left of centreline (as seen by an aircraft) at 1.35° (0.45θ) would be reduced from approximately 320µA to 280µA. The minimum requirement is 190µA.

7.6.8 Whilst some disturbance is evident, it is not sufficient to exceed any operating tolerances or cause downgrading of the facility performance category. Whilst the effect may be measurable to suitably equipped aircraft, it would probably be unnoticeable to most users.

7.6.9 The second option, The Circle Freight building request submitted by Chipshol in 1999, referred to here as Circle Freight 2, comprises a rectangular building 120m x 85m and 8m high as depicted in Figure 47. The dimensions of the illuminated face were increased to 100m x 10m to compensate for any inaccuracy in location. Model configuration is shown at Figure 48.

7.6.10 Interestingly, most of the Circle Freight 2 building is screened from the glidepath by the red and white concrete building (Airfield ground lighting switching centre?). This was not however taken into account in the model.

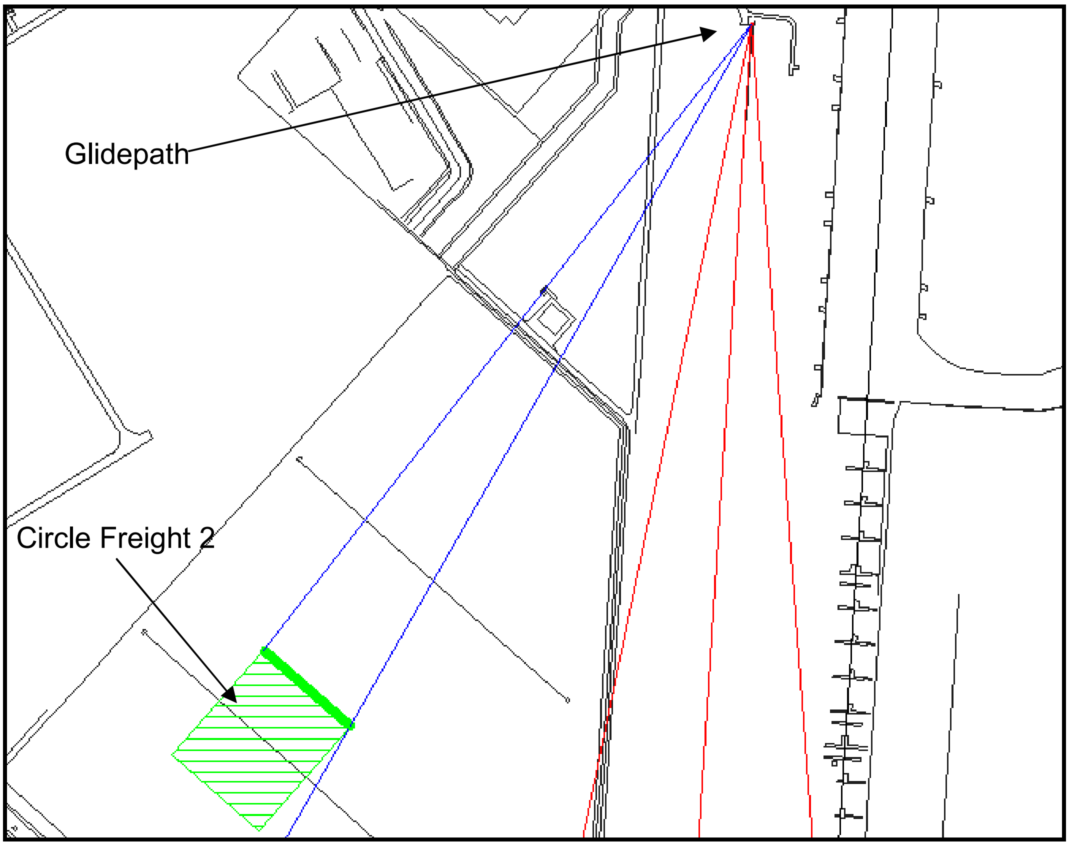


Figure 47. Circle Freight 2 layout

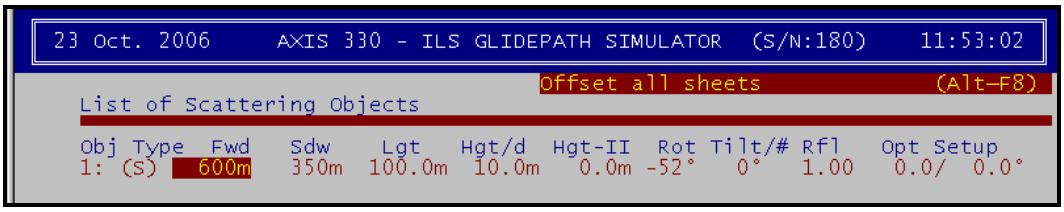


Figure 48. Illuminated face of Circle Freight 2.

7.6.11 The results of the simulation are shown at Figures 49-50.

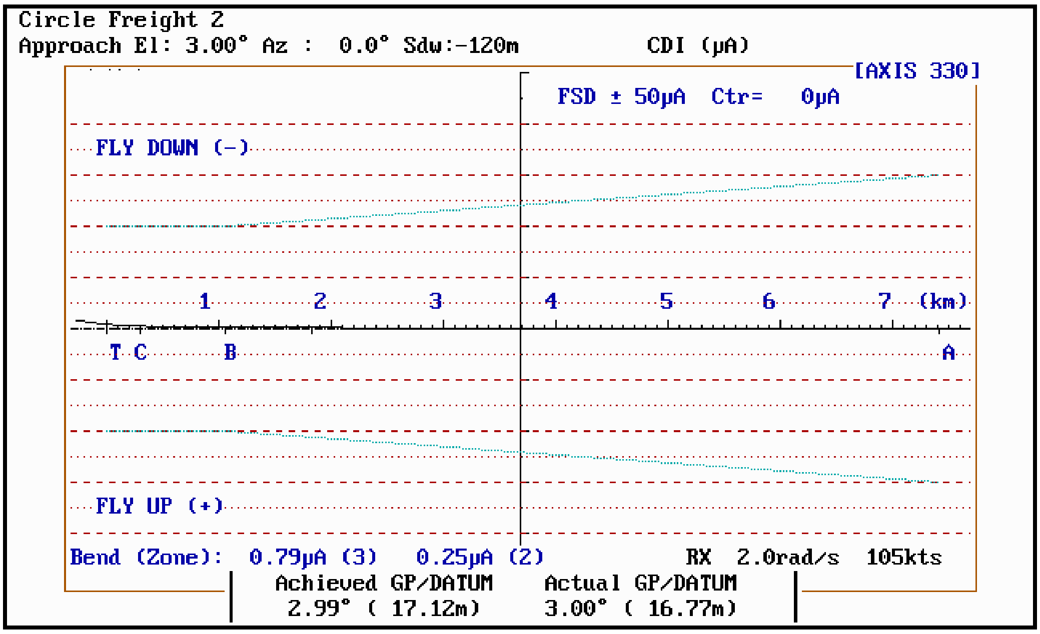


Figure 49. Circle freight 2 – Glidepath Course Structure

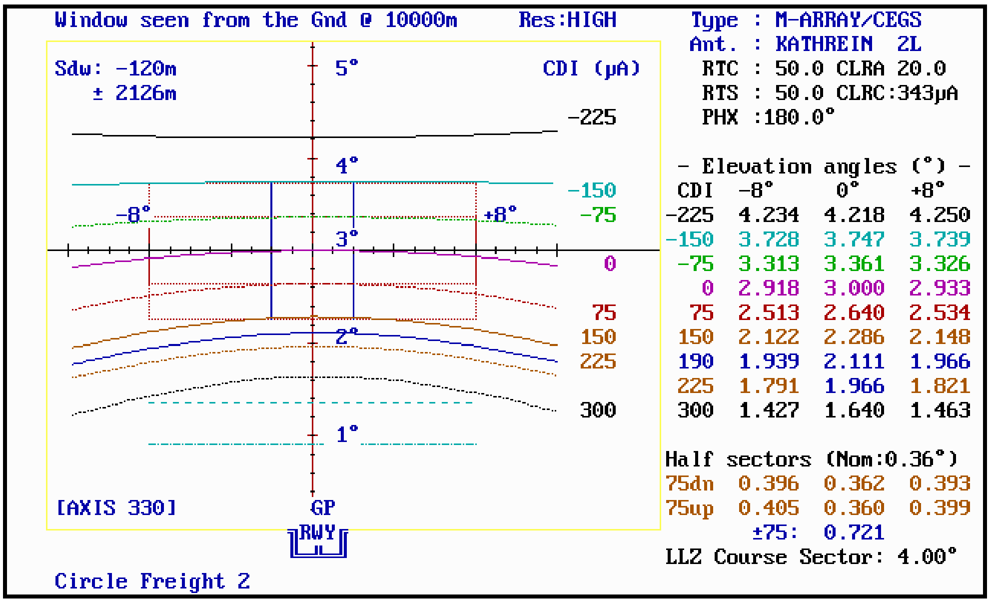


Figure 50. Circle Freight 2 – Window Overview

7.6.12 From analysis of the output from the simulation, there is no evidence of measurable disturbance to the ILS glidepath or justification for objection to planning applications.

7.7 Truck Parking (2002)

7.7.1 NLR identified that the truck parking component of the model was a particularly strong contributor to predicted degradation of the glidepath course structure. This aspect is explored here in more detail.

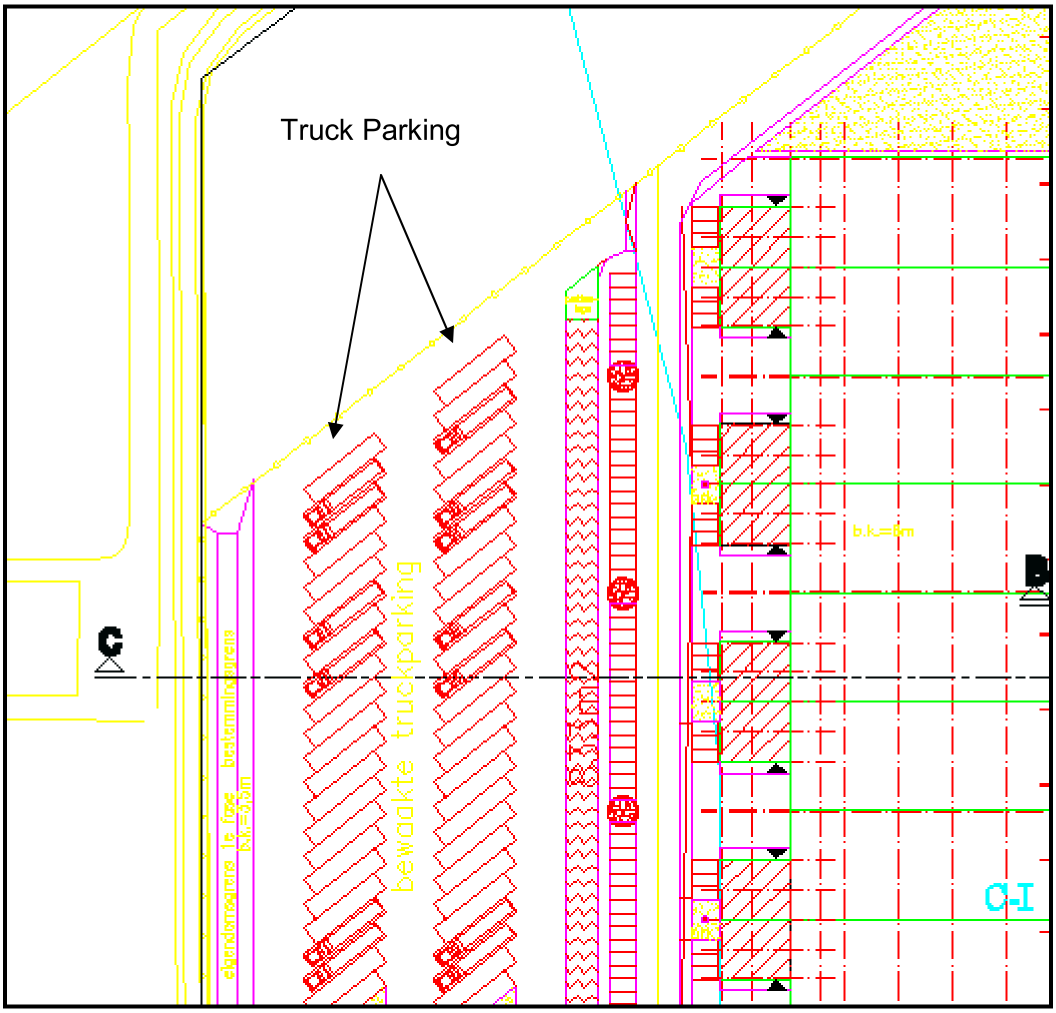


Figure 51. Truck Parking

7.7.2 As described in Section 6.2, the majority of the truck parking is afforded screening from the ILS glidepath by the 3.5m embankment. The main issue is the trucks parked at the east end of the zone which are illuminated by the glidepath and are also parallel to the runway.

7.7.3 For the purpose of the model, the two end trucks are each modelled as 18m long by 4m high and parallel to the runway. These measurements exceed EU standard truck sizes in order to represent worst-case.

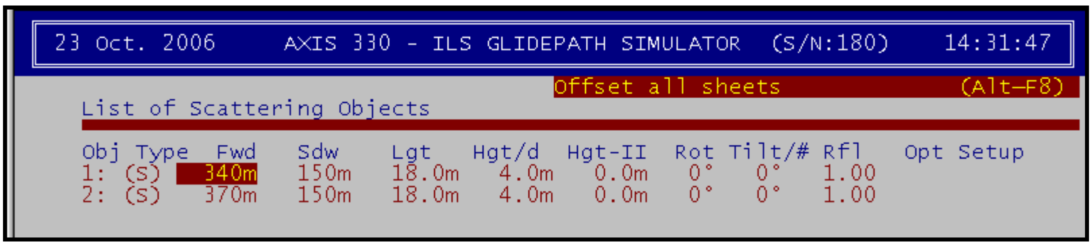


Figure 52. Configuration of Truck parking model.

7.7.4 The nominal area for truck parking was established as 140m from the glidepath centreline. The simulation was run several times with the trucks at different distances from the glidepath centreline as the effects were noticed to be quite variable with distance.

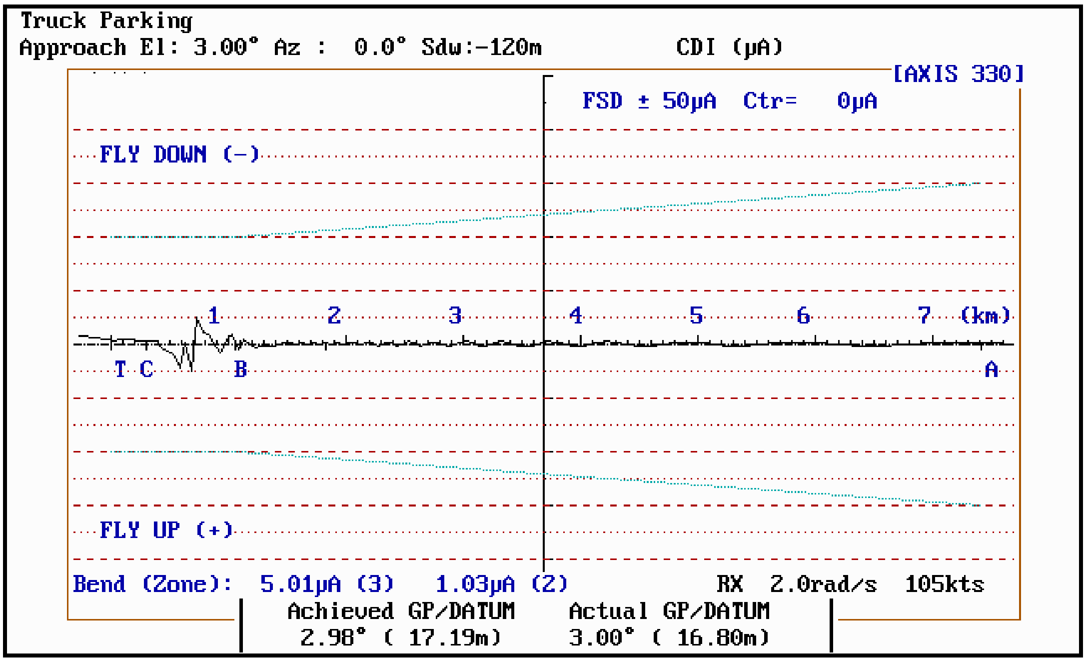


Figure 53. Trucks parked at 140m

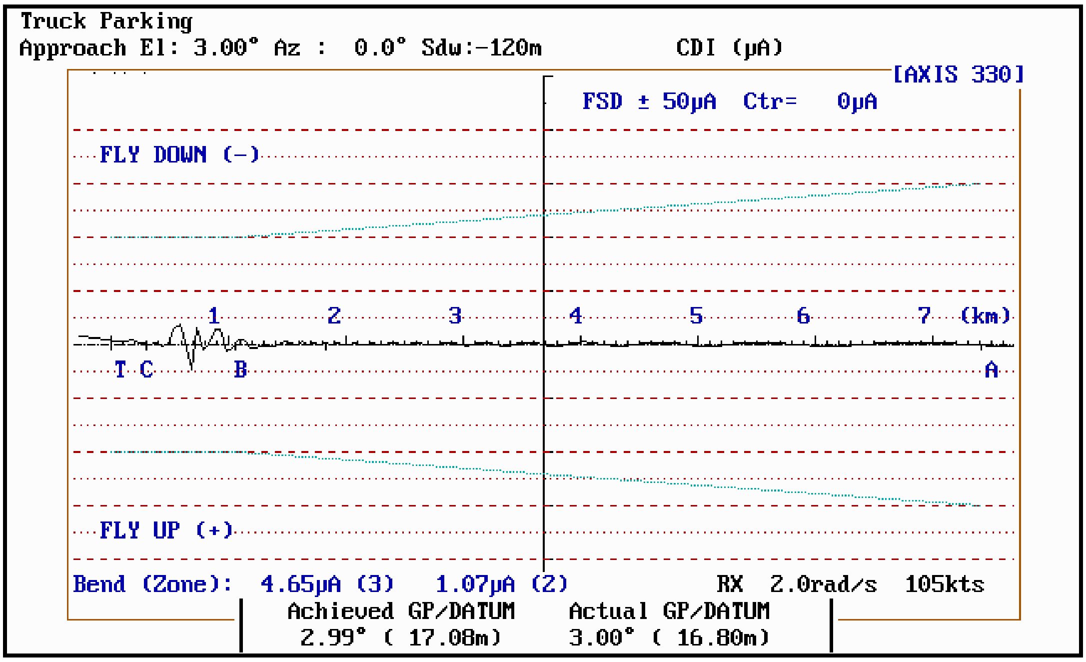


Figure 54. Trucks parked at 135m

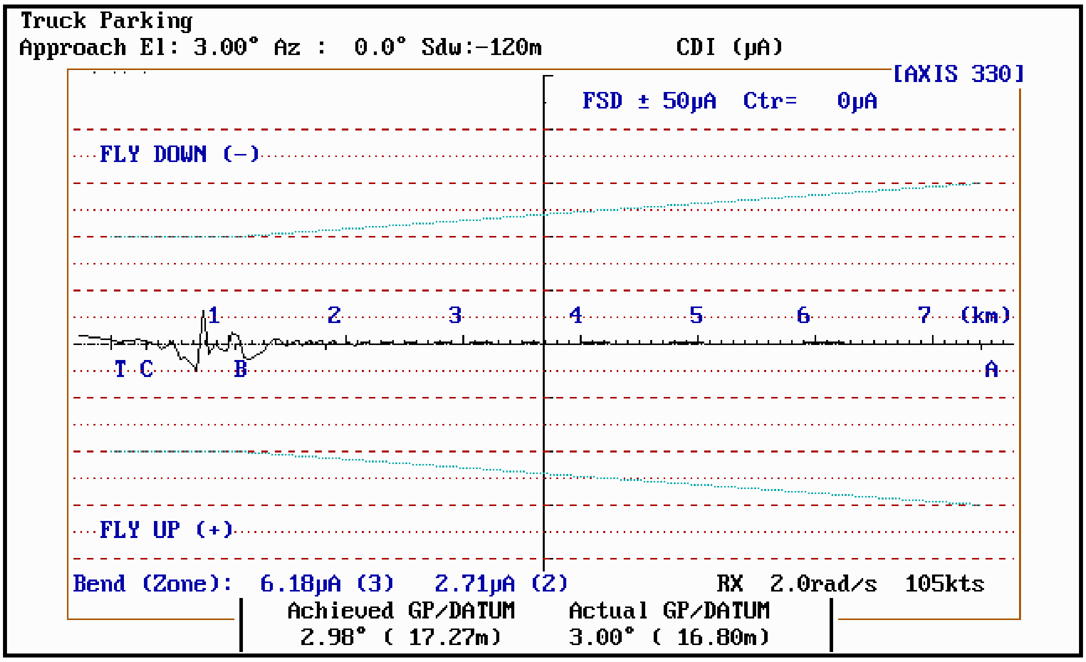


Figure 55. Trucks parked at 125m

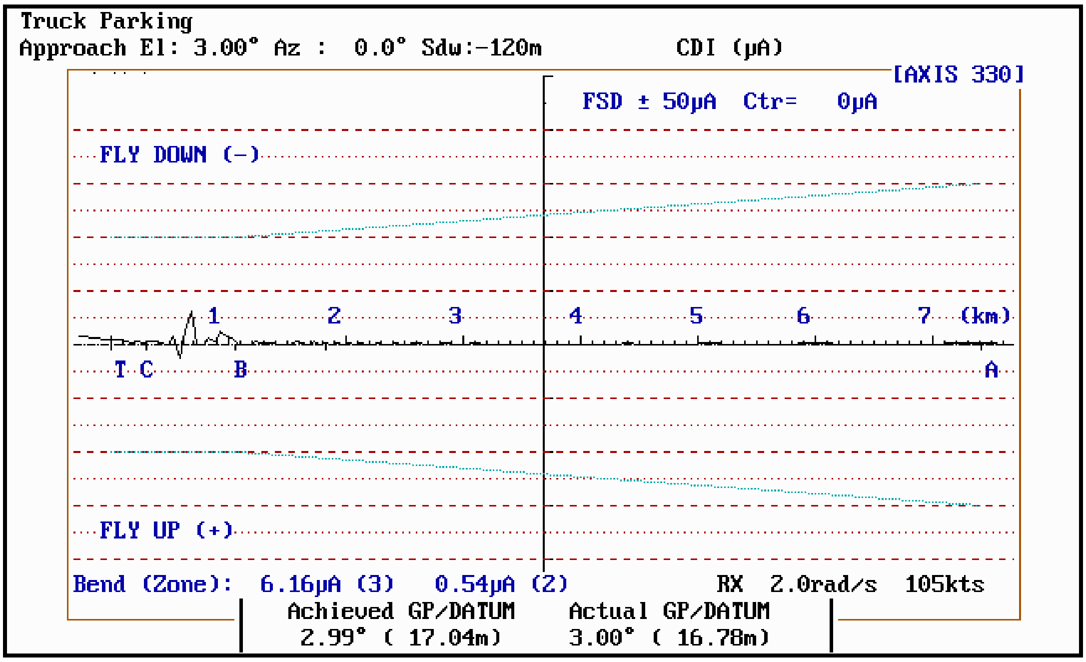


Figure 56. Trucks parked at 150m

It is interesting to note that the effect at 150m is greater than the effect predicted at 135m.

7.7.5 It should be noted that the vertical scaling of the equivalent graphs is expanded in the NLR report compared to other similar plots in this report. The NLR graphs visually indicate a greater disturbance. All glidepath course structure plots within this report are to the same scale (±50µA)

7.7.6 From the modelling carried out, the concerns raised over the truck parking by LVNL are overstated. The figures derived from the simulation, whilst being higher than desirable, are within the limits quoted by LVNL. For further analysis of Error Budgets, see section 7.10.

7.7.7 The problem with the truck parking is mainly due to the trucks being parallel with the runway. This could be overcome either by changing the orientation of the truck parking such that the trucks do not park parallel with the runway as per figure 56a, or by screening the truck park as discussed in section 7.5.

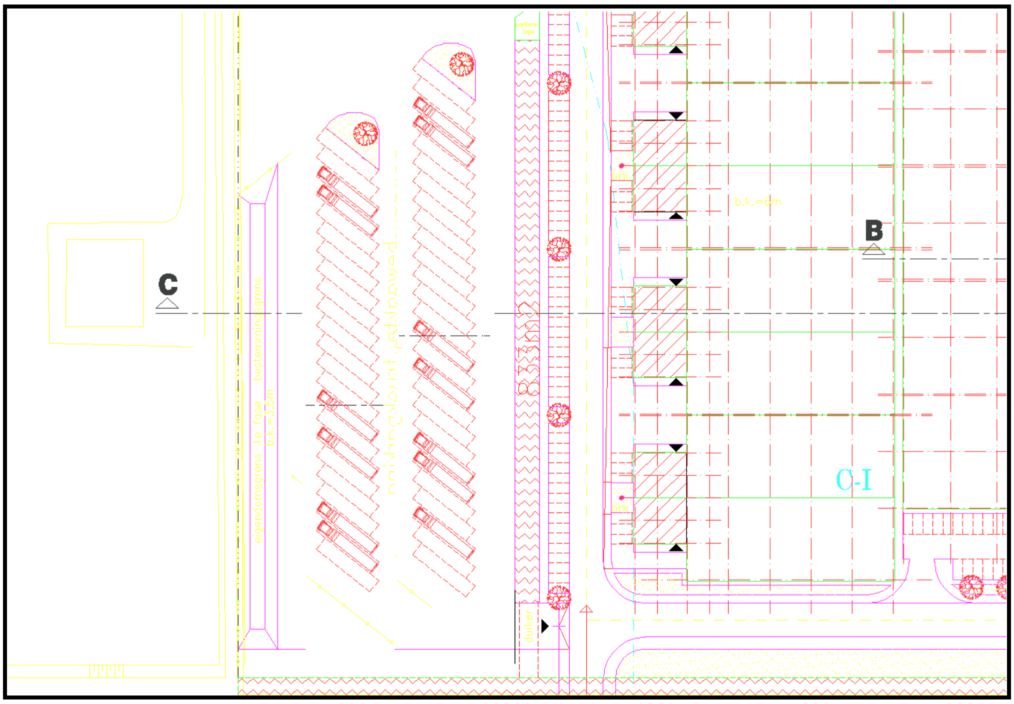


Figure 56a. Truck parking not parallel to runway.

7.7.8 The modified truck parking is shown on the plan drawing at Figure 56b.

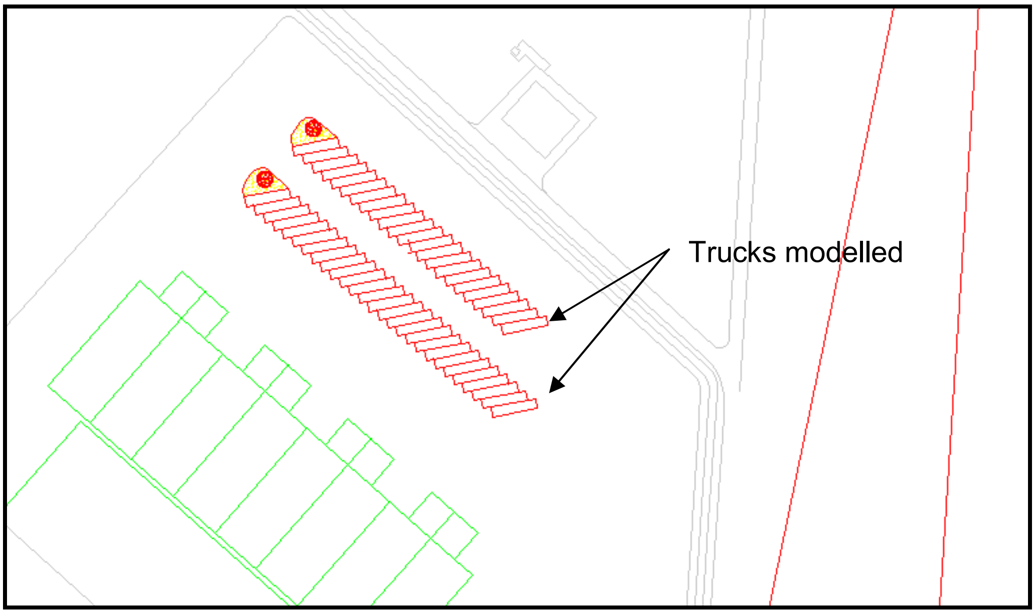
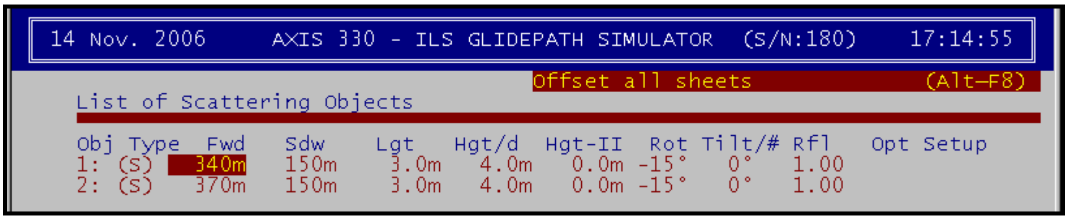


Figure 56b. Plan of modified truck parking.

7.7.9 Only the ends of the two trucks identified in Figure 56b are modelled. The sides of the trucks illuminated by the ILS glidepath would reflect energy away from the aircraft flight path and are thus ignored.

7.7.10 The ends of the other parked trucks would reflect energy into trucks between themselves and the runway and are also ignored. The configuration of the model is shown at Figure 56c, and the resultant course structure at Figure 56d.



14 Nov. 2006 AXIS 330 - ILS GLIDEPATH SIMULATOR (S/N:180) 17:14:55

Offset all sheets (Alt-F8)

List of Scattering Objects

Obj	Type	Fwd	Sdw	Lgt	Hgt/d	Hgt-II	Rot	Tilt/#	Rfl	Opt	Setup
1:	(S)	340m	150m	3.0m	4.0m	0.0m	-15°	0°	1.00		
2:	(S)	370m	150m	3.0m	4.0m	0.0m	-15°	0°	1.00		

Figure 56c. Configuration of model

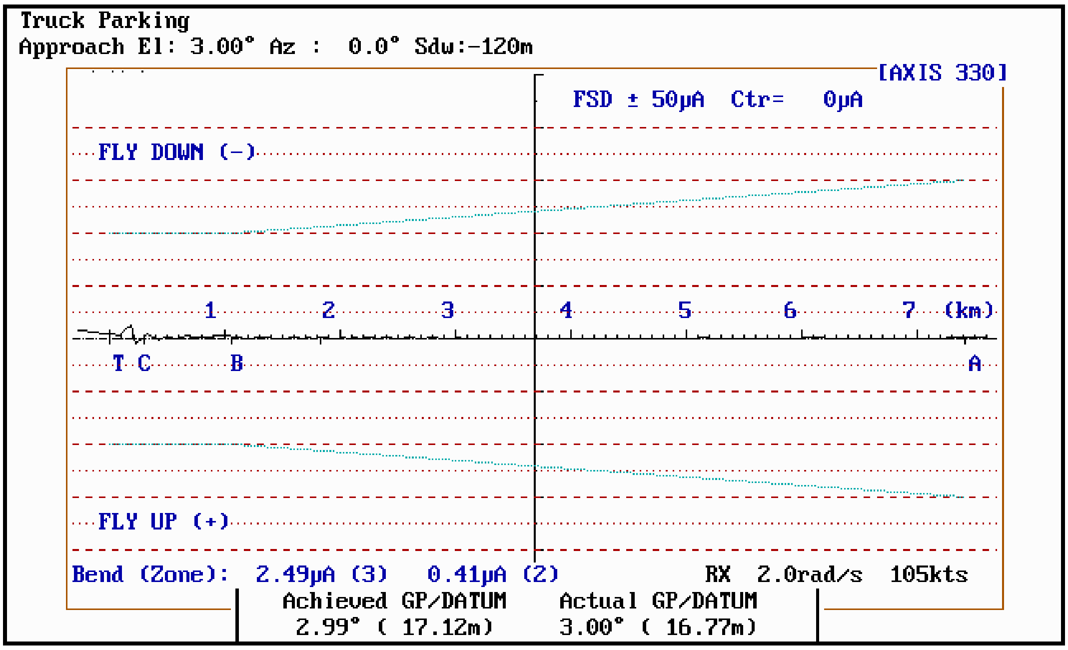


Figure 56d. ILS Glidepath course structure – Modified Truck Parking

7.7.11 It is evident that changing the orientation of the trucks reduces the disturbance to the glidepath by a significant amount compared to trucks parked parallel to the runway. Whereas the error caused by parallel trucks was in the worst scenario 6.18µA (best scenario 4.65µA) the error caused when the truck orientation was rotated dropped to 2.49µA. The error budget of LVNL was 6.42µA (11.84µA Cyrrus). Changing the orientation of the trucks would make the plan well within the limits.

7.7.12 As the truck parking is variable, it raises the question as to whether this should be allocated to the static or dynamic budget. A reasonable resolution would be to allocate half of the potential disturbance to static bends and half to dynamic bends.

7.8 Areas A and B 1998

7.8.1 In section 5, it was established that the LVNL glidepath simulation was not representative of development in areas A and B. To address this in more detail, a simulation has been carried out which is considered representative of development in the areas in question.

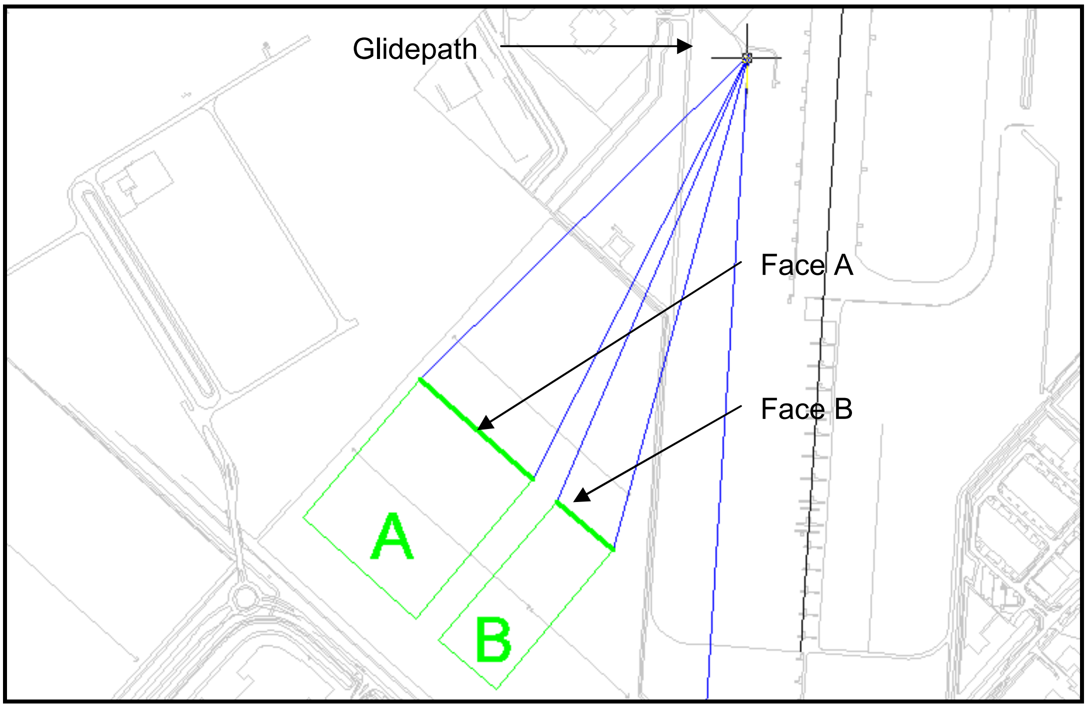


Figure 57. Areas A&B Plan View

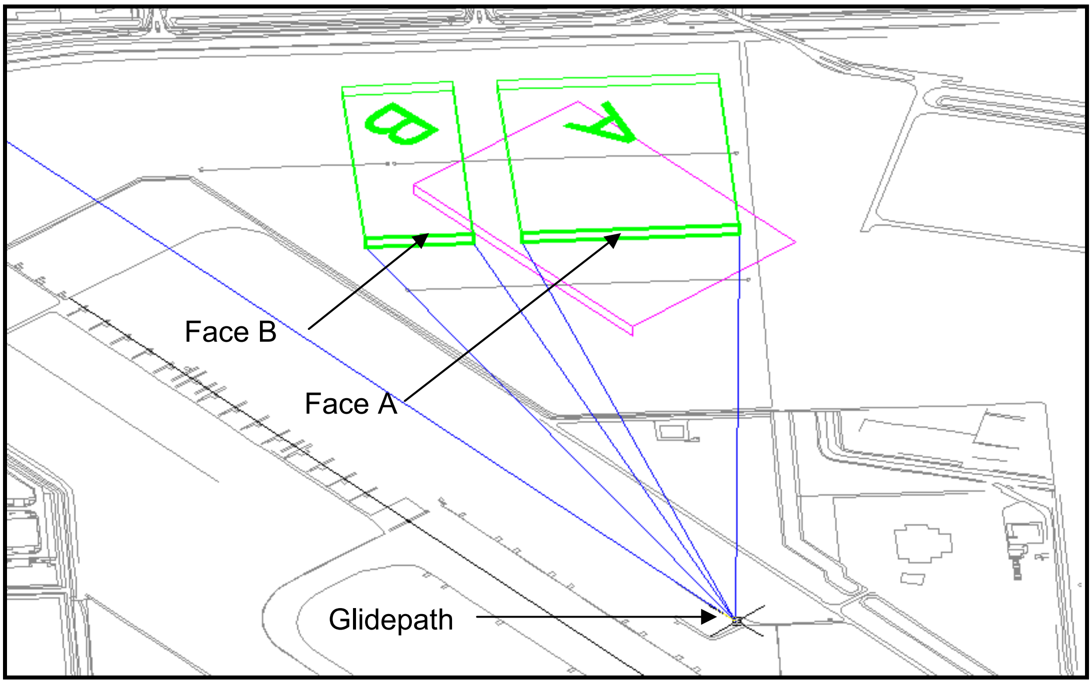


Figure 58. Areas A&B – Isometric View – LVNL model shown in Magenta.

7.8.2 Figures 57 and 58 show areas A and B represented in green on a drawing of the Airport. The original LVNL simulation is shown as the magenta object in Figure 58. The distances of the faces of typical buildings relative to the glidepath were derived from the drawing and entered into the AXIS simulation.

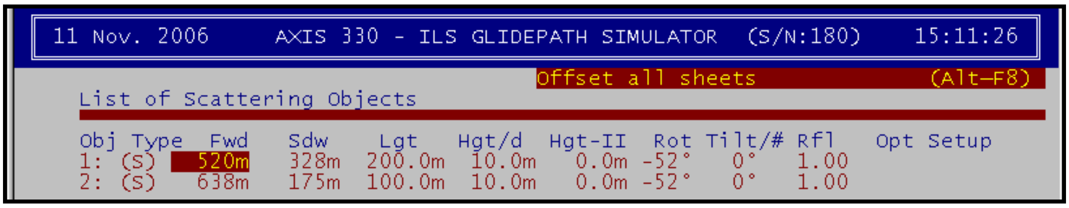


Figure 59. Scattering objects for area A & B evaluation.

7.8.3 The building for area A was taken as a 200m wide smooth metal plate, the initial height being 10m. The building for area B was taken as a 100m wide smooth metal plate, the initial height being 10m.

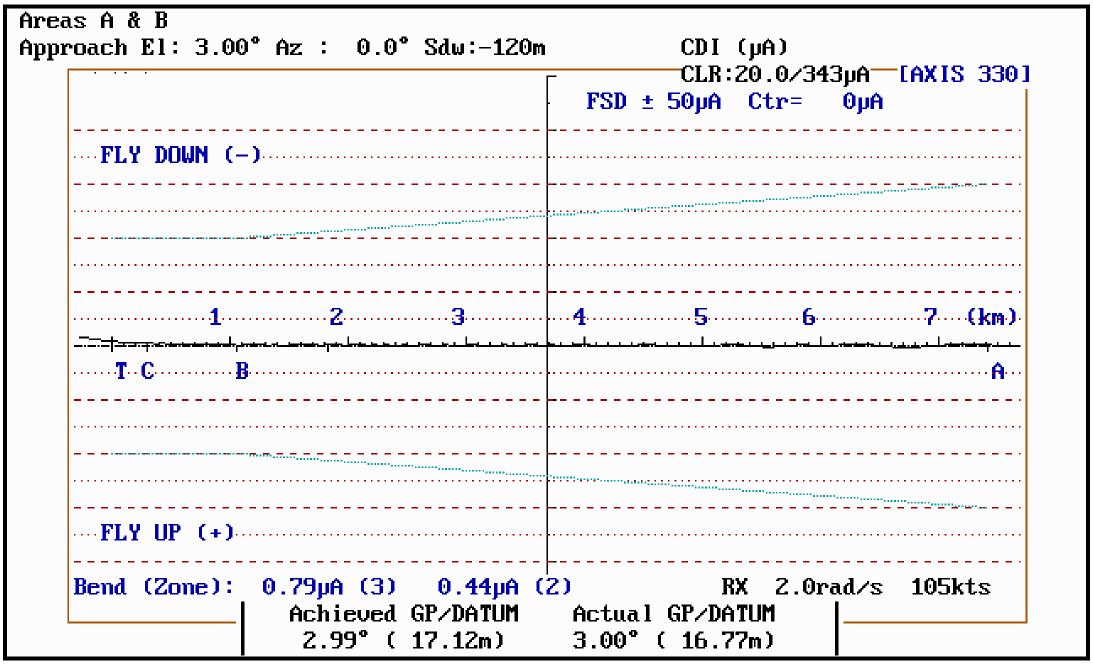


Figure 60. Glidepath Course Structure - 10m buildings at areas A & B.

7.8.4 10m high buildings on areas A & B, oriented as per the drawing have very little effect on the glidepath course structure.

7.8.5 To assess the effects of building height, further simulations were made looking at each building individually and increasing the height of the building.

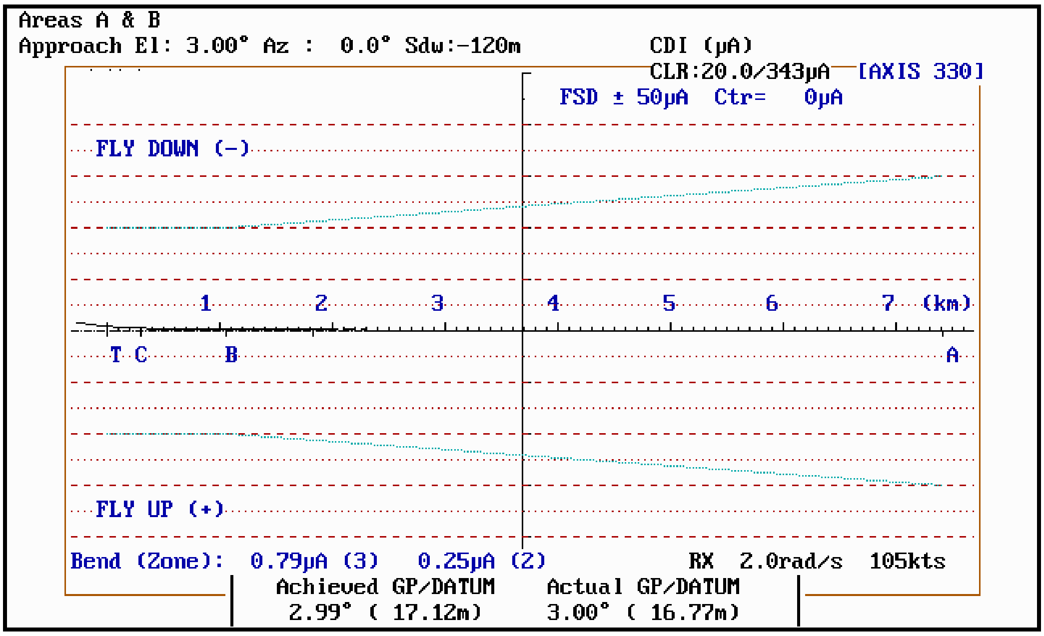


Figure 61. Glidepath Course Structure - 20m building at Area A.

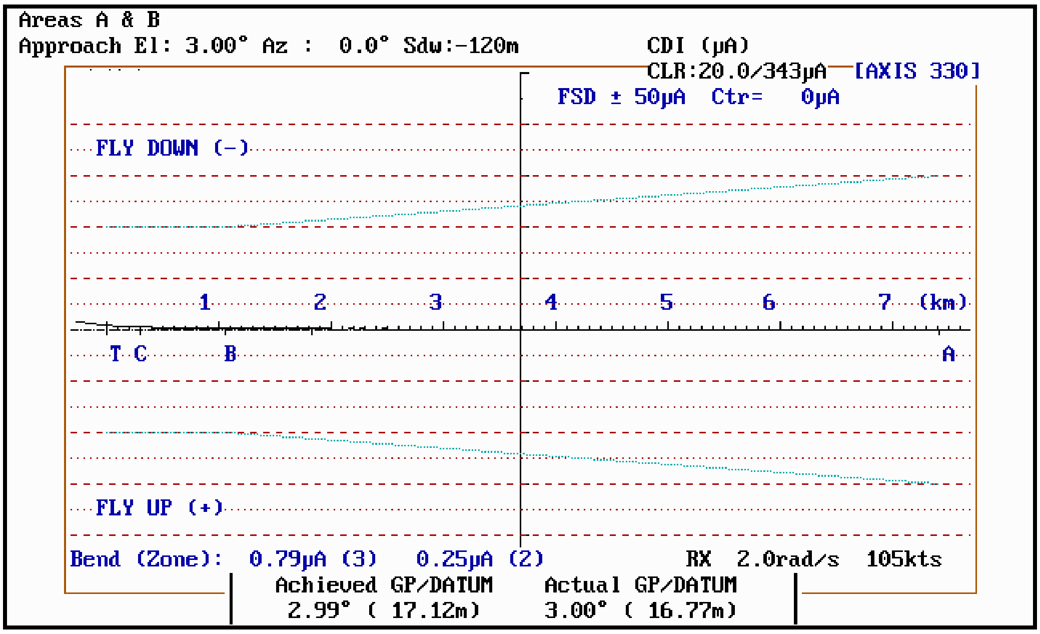


Figure 62. Glidepath Course Structure - 30m buildings at Area A.

7.8.6 It can be seen that increasing the height of building A has no effect on the glidepath course structure.

7.8.7 Area B is now investigated with no buildings at area A

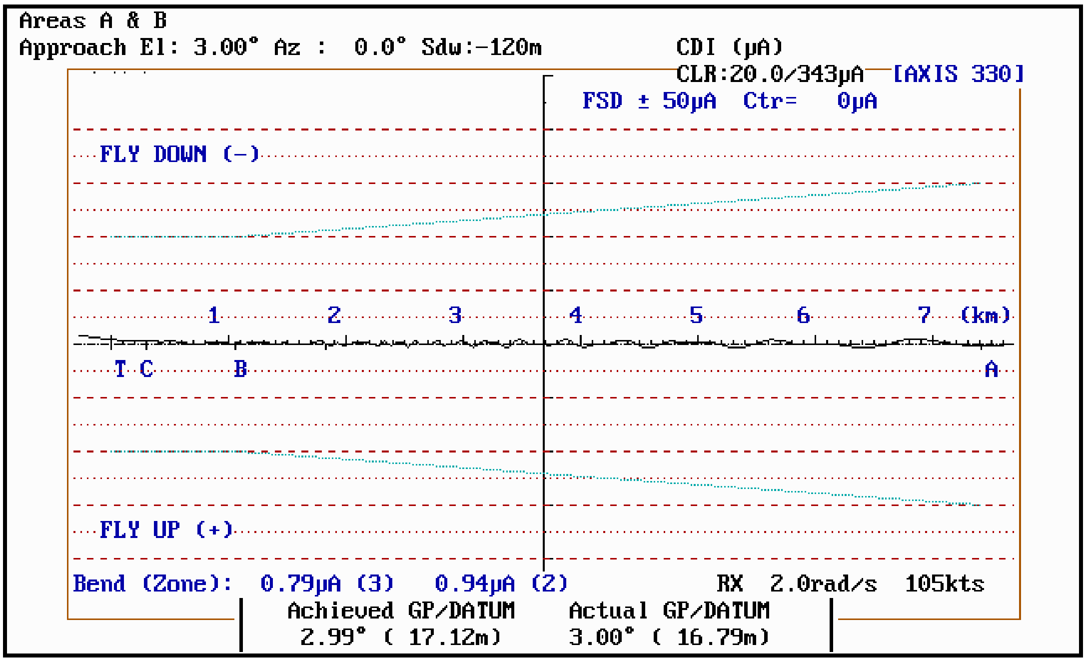


Figure 63. Glidepath Course Structure - 20m building at Area B.

7.8.8 A 20m tall building at area B has some effect on the glidepath course structure, but the effect is very small.

7.8.9 Finally, the combined effect of a 20m building at Area B and a 30m building at area A is investigated.

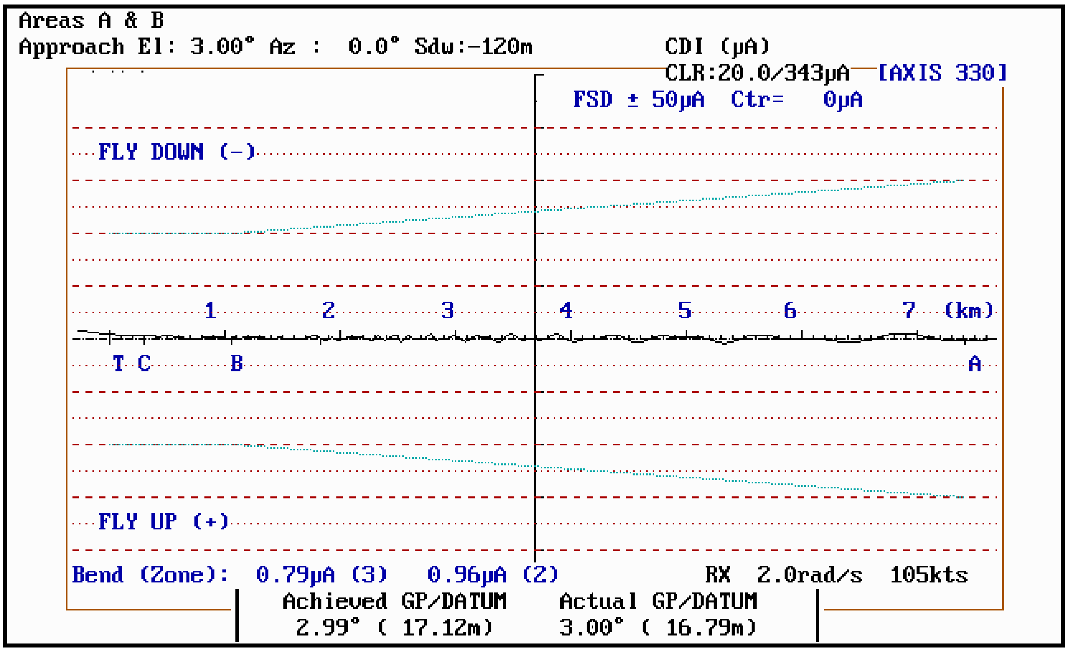


Figure 64. Glidepath Course Structure – 30m building at A and 20m building at B.

7.8.10 As figure 64 shows, there is little effect even from the combined largest buildings. A window overview is shown at Figure 65, which remains within acceptable limits.

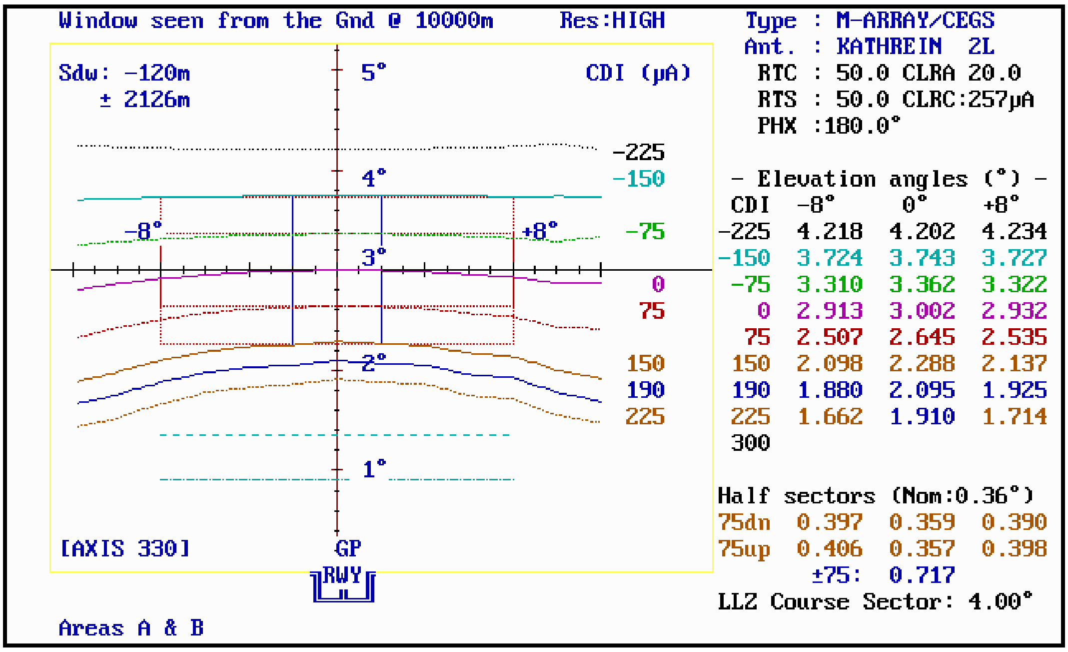


Figure 65. Glidepath Window Overview – 30m building at A and 20m building at B.

7.8.11 From this simulation, it has not been possible to validate any building height restrictions based on ILS glidepath performance. Indeed, the simulation indicates that the construction of quite large buildings is possible at the orientation depicted in the drawing.

7.9 Height Restrictions

7.9.1 The original plan submitted regarding the development of the GBT in 1998 identified two areas, A and B. LVNL advised Chipshol that the maximum building heights for these two areas were 3m and 0m respectively Ref LVNL 900475.

7.9.2 Apart from the simulation presented by LVNL, the reasoning behind the statement was not given. Some investigation has therefore been undertaken to determine possible justifications for the building height restrictions.

7.9.3 It is accepted that the GBT falls within the safeguarded areas for certain radio navigation facilities, however, that in itself is not a limitation on building height provided suitable analysis and investigation of the proposed development has been carried out.

7.9.4 Building height is only one variable which affects the degree of ILS beam distortion. Annex A details that it is possible to construct quite large buildings on the GBT without excessive disturbance of the ILS glidepath. Similarly, some small buildings or even trucks at the wrong places and orientation could have an adverse effect. The all-encompassing building height restrictions are therefore dismissed in this instance.

7.9.5 The areas A and B relative to the original LVNL glidepath model are depicted in Figure 66. The LVNL model is not considered representative of construction in areas A and B.

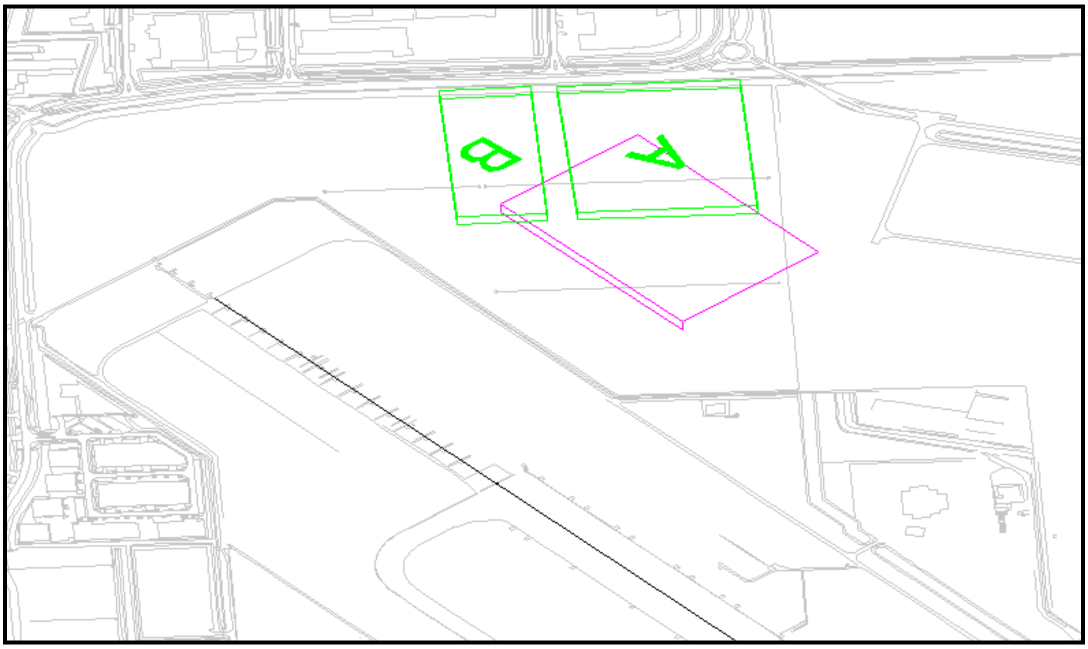


Figure 66. Areas A&B with LVNL Glidepath model overlaid.

7.9.6 There are Obstacle Limitation Surfaces defined in ICAO Annex 14 for all licensed runways. These are detailed in Section 7.2. The GBT is located under the Transitional and Inner Horizontal obstacle limitation surfaces. No construction is allowed to penetrate these surfaces; otherwise it would pose a collision risk to aircraft using the airport. The maximum obstacle heights for the GBT are shown at Figure 67.

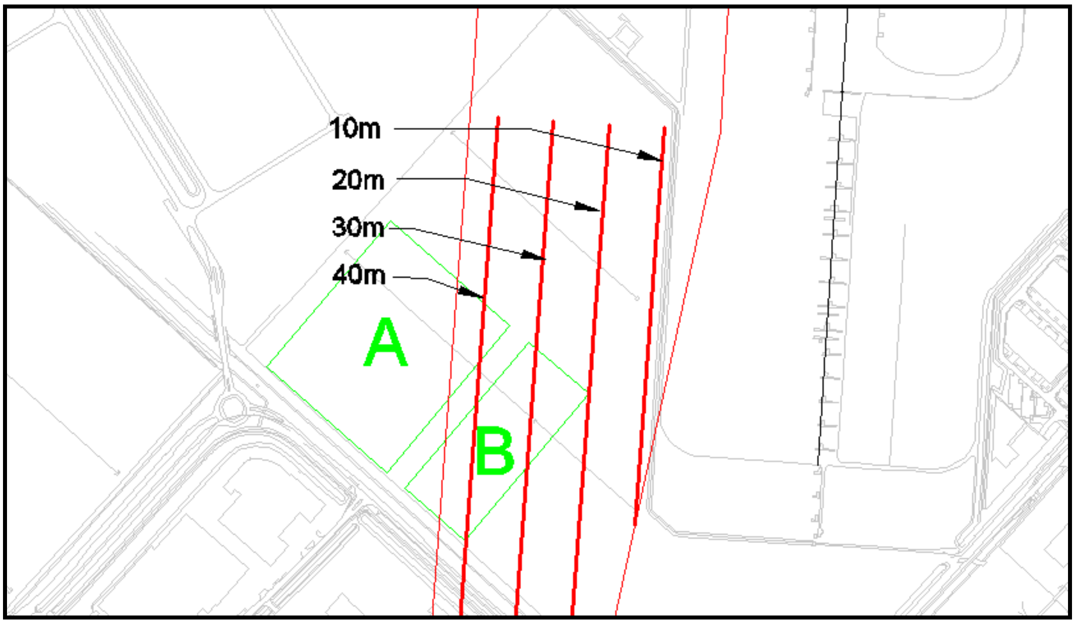


Figure 67. OLS Building heights at areas A and B.

7.9.7 In Figure 67, the area to the left of the thin red line crossing area A is 45m. All heights are relative to the runway threshold. The OLS is not a limiting factor for construction within the GBT.

7.9.8 Other Radio Navigation facilities are considered in Figure 68.

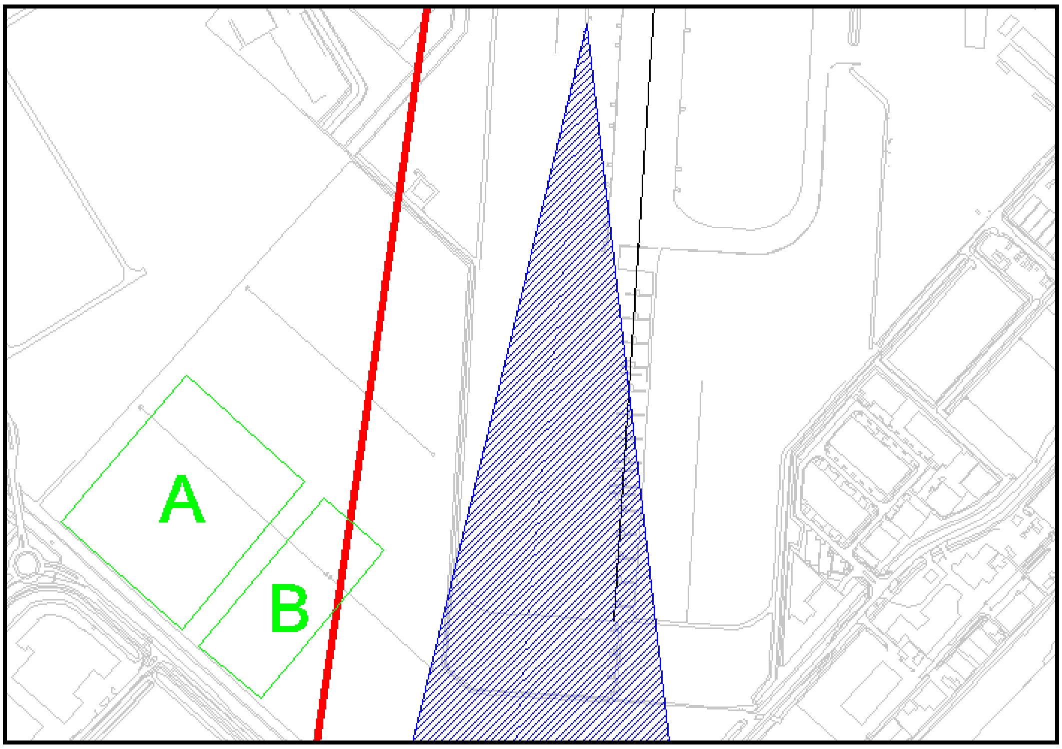


Figure 68. MLS and ILS Localiser considerations for areas A and B.

7.9.9 Figure 68 illustrates the sector within ±10° of the MLS elevation which is shaded blue. This is well clear of areas A and B. The area to the left of the red line is shielded from ILS Localiser illumination by the storage tanks to the north. Neither of these facilities should preclude building nor impose maximum building heights on areas A and B.

7.9.10 The only other criterion that is readily apparent that restricts objects and building heights in the vicinity of an airport are the Obstacle Assessment Surfaces (OAS) which protect the Instrument Approach Procedures. These surfaces are defined in ICAO Document 8168 (Pans-Ops). Unlike the OLS, the OAS are defined around the aircraft flight path. Obstacles in the vicinity of the airport determine the minimum descent height for aircraft using instrument flight procedures. ICAO additionally provides a Collision Risk Model for ILS which numerically calculates the collision risk for each obstacle. The overall risk per approach must be below internationally accepted figures. The assessment of OAS and Approach Collision Risk are outside of the scope of this report, however, experience in Instrument Procedure Design suggests that the building height restrictions quoted for areas A and B are unlikely to be as a result of Instrument Flight Procedure criteria.

7.9.11 Although the GBT falls within the safeguarded zone, the all-encompassing building height restrictions are not considered appropriate. For ILS disturbance, the orientation of a building is of greater importance. The LVNL model used a building parallel to the runway whereas Chipshol planned buildings in areas A and B which were not parallel and would therefore not have caused the magnitude of ILS disturbance as predicted by the LVNL model.

7.10 Error Budgets

7.10.1 The maximum tolerance for glidepath disturbance is stated in ICAO Annex 10. For a Category III glidepath, this is:

- **Zone 2**: ±30µA at ILS Point A (4NM or 7.41km from the runway threshold) decreasing to ±20µA at ILS Point B (1,050 m from the runway threshold).
- **Zone 3**: The tolerance remains at ±20µA from ILS point B to the runway threshold.

7.10.2 The main concern is Zone 3 and the latter part of Zone 2. In this region the maximum tolerance is ±20µA. Some part of this budget is normally reserved for dynamic disturbances from sources such as moving aircraft, vehicles, equipment noise, seasonal variations, temporary works etc. Any buildings or constructions in the vicinity of the beam forming area will create disturbances which are inherently static. The resultant beam is a sum of the static and dynamic disturbances.

7.10.3 LVNL allocates 50% of the total error budget to static bends, reserving 50% for dynamic bends. The combination of dynamic and static errors is the vector sum of the errors and therefore not a straight arithmetic addition. The addition of vector quantities is established using a Root Sum Squares (RSS) method as shown below.

$$TotalError = \sqrt{StaticError^2 + DynamicError^2}$$

7.10.4 The total allowed error is 20µA in this region.

$$20\mu A = \sqrt{StaticError^2 + DynamicError^2}$$

7.10.5 As the allocation of error budget is 50% to each contributor: StaticError = DynamicError

7.10.6 The Error budget for both Static and Dynamic errors is therefore;

$$\sqrt{\frac{20\mu A^2}{2}} = 14.14\mu A$$

7.10.7 LVNL concluded that 54.6% (7.72µA) of the static bend allowance was already used. NOTE: it is not clear if this figure excluded any dynamic bends or signal noise at the time of the measurement.

7.10.8 As the static bends are the vector sum of all of the reflecting objects, not the arithmetic sum as in the NLR report, the remaining static error budget is:

$$14.14\mu A = \sqrt{7.72\mu A^2 + \mathrm{Re}\,mainingErrorBudget^2}$$

7.10.9 The remaining total static error budget is therefore:

$$\sqrt{14.14^2 - 7.72^2} = RemainingErrorBudget$$

$$= 11.84\mu A$$

7.10.10 The most contentious issue identified by NLR and LVNL is the truck parking. LVNL/NLR identified 6.65µA of possible disturbance due to truck parking. To demonstrate caution and allow for errors, for the purposes of this calculation, the figure is increased by 25% to 8.31µA. We must now determine the remaining static error budget, again by vector calculation;

$$11.84\mu A = \sqrt{8.31\mu A^2 + RemainingErrorBudget^2}$$

$$\sqrt{11.84^2 - 8.31^2} = 8.43\mu A$$

7.10.11 As the truck parking is variable, it raises the question as to whether this should be allocated to the static or dynamic budget. A reasonable resolution would be to allocate half of the potential disturbance to static bends and half to dynamic bends.

7.10.12 It is considered that the LVNL calculation of residual error budget by arithmetic addition was incorrect. LVNL explained the division of the total error budget between dynamic and static bends by Root Sum Square method in their letter of 6th June 2003, reference S&I/NAV 15513. It is then inconsistent not to divide the static error budget between existing errors and additional errors by the same method.

7.10.13 By application of an arithmetic rather than vector addition when calculating error budgets, LVNL has placed a greater restriction on building development than is considered reasonable. Simulations for areas A and B, GBT813bl01, Circle freight and the truck parking would have been within the declared error budget.

8 Chipshol Questions

8.1 The questions asked by Chipshol are listed below in SMALL CAPS together with answers in *blue italics* provided by Cyrrus Associates Ltd.

1996 Rezoning advice LVNL

a. IS THE STATEMENT THAT THE APPLICABLE AREA SHOULD MAINTAIN ITS AGRICULTURAL DESIGATION IN CONNECTION WITH ILS INTERFERENCE CORRECT?

Although the area falls within the safeguarded area of the ILS glidepath serving runway 36R, this in itself is not a justification to prevent development.

b. CAN THE POSITION OF AN ILS BE MOVED?

Technically, the ILS glidepath could be relocated to the East side of the runway, although there may be very good technical and operational reasons why this would not be acceptable.

c. IS IT CORRECT TO ADVICE AGAINST REZONING OF AREA A1 BECAUSE IT IS SITUATED IN THE GLIDE PATH INTERFERENCE ZONE?

The GBT is within the safeguarded zone. This in itself is not a justification to oppose development unless it can be demonstrated that the development would have an unacceptable effect on ILS performance.

1998 Rezoning advice LVNL

d. DOES THE SIMULATION EXECUTED LEAD TO THE CONCLUSION THAT THE BUILDING HEIGHT OF AREA A AND B WAS RESTRICTED TO RESPECTIVELY 3 AND 0 METERS ?

The simulation does not provide any evidence in which the conclusion of maximum building heights could be based.

e. IS THE STATEMENT OF LVNL CORRECT THAT DUE TO ILS RESTRICTIONS THE MAXIMUM CONSTRUCTION HEIGHT IN AREA A IS 3 METERS AND FOR AREA B NO CONSTRUCTION AND/OR NOR PARKING PLACES ARE ALLOWED?

There are no known ILS restrictions that would incur the universal building height restrictions stated.

f. WOULD CONSTRUCTION IN AREAS A AND B IN EXCESS OF RESPECTIVELY 3 AND 0 METERS LEAD TO DECLASSIFICATION OF THE ILS FROM CAT III TO CAT I OR CAT II?

There is no evidence from the simulation that development as planned in Areas A and B would result in downgrading of the ILS facility performance category.

g. WHICH MAXIMUM CONSTRUCTION HEIGHT IS IN YOUR OPINION ACCEPTABLE IN RESPECTIVELY AREA A AND AREA B?

Subject to modelling to ensure no detrimental effect on the ILS, the maximum building heights are limited by the Obstacle Limitation Surfaces in defined ICAO Annex 14. These heights are > 20m for area B and >35m for area A. Buildings of 20m in area B and 30m in area A can be constructed at a suitable orientation to reduce effects on the ILS glidepath to an acceptable level.

h. WHICH MAXIMUM CONSTRUCTION HEIGHT IS IN YOUR OPINION ACCEPTABLE FOR THE ENTIRE GBT CONSIDERING THE THEN APPLICABLE ILS CONFIGURATION?

The maximum height for the entire GBT would be dependant on the building orientation. Buildings parallel to the runway and located towards the north eastern part of the site would be restricted to less than 3m. Careful design of the buildings would allow 9m buildings at the eastern side of the site, increasing to in excess of 20m at the western side without excessive disturbance of the ILS.

LVNL in their May 15th and July 23rd 1998 letters refer to a simulation.

i. COULD YOU RECOMPILE FROM THAT SIMULATION WHAT LVNL' S ASSUMPTIONS WERE AND IF SO IF THOSE WERE CORRECT CONSIDERING A BEST PRACTICE EFFORT?

The 1998 ILS glidepath simulation by LVNL has been investigated and the conclusion reached that the simulation was neither worst-case nor representative. The configuration used served to exaggerate the effects on the glidepath. As such, the simulation, and the conclusions drawn from it cannot be considered best practice.

j. DID LVNL ACTUALLY MAKE A SIMULATION OF PLAN A AND B IN THIS SIMULATION? IF NOT WHAT TYPE AND ORIENTATION HAD THE BUILDING ON WHICH THE SIMULATION WAS EXECUTED? PLEASE ELABORATE ON THE CONSEQUENCE OF THE ORIENTATION OF THE SIMULATED BUILDING.

The 1998 ILS glidepath simulation by LVNL did not model areas A and B. The building simulated was a 300m long by 10m high smooth metal plate orientated parallel to the runway. This represented a worst-case rather than realistic simulation. Buildings of the orientation proposed by Chipshol have very little impact on ILS Glidepath performance compared to buildings parallel to the runway.

k. IF YOU JUDGE THE LVNL SIMULATION WHAT ARE YOUR CONCLUSIONS?

- WAS THE ASSESMENT EXECUTED IN ACCORDANCE WITH BEST PRACTICE STANDARDS. IF NOT WHY NOT.

The 1998 ILS glidepath simulation by LVNL was not representative of the design proposed by Chipshol. It would be reasonable to expect that as Chipshol had provided drawings of the development, that LVNL would assess a realistic scenario and base any response on the outcome. Had this been carried out using realistic scenarios, then it would not have substantiated objections to the 1998 rezoning plan, the 1999 Circle Freight plan, or the 2002 GBT813bl01 plan.

The incorrect calculation of remaining error budgets has resulted in conclusions been drawn and decisions made which are difficult to substantiate. As a result, objections have been made on a false premise to plans that fall within the remaining error budget.

It is not unreasonable to expect the developer to be informed of the effects of building design and layout and how these may be optimised to minimise any effects on ILS performance. The truck parking is an example where a simple design change could have removed the reason for the objection.

- IF NOT, WOULD THE RESULT HAVE BEEN MATERIALLY DIFFERENT

A realistic appraisal of areas A and B would have revealed that even buildings much larger and higher than those proposed by Chipshol would have negligible impact on ILS Glidepath performance.

1999 Circle Freight Building Request

l. IN ITS REJECTION OF THE SPECIFIC CIRCLE FREIGHT BUILDING REQUEST, LVNL REFERS TO THE MOTIVATION OF THE NOVEMBER 16TH 1998 LETTER. IS THIS MOTIVATION VALID?

The rejection refers to buildings within the safeguarded areas for ILS; this in itself is not a cause for rejection without a technical assessment. There is no evidence from a technical assessment that the Circle Freight facility as proposed was either modelled or found to have adverse effects in ILS performance.

Building height is only one parameter of the building that influences the effect on ILS performance. There are other parameters that can have a significantly greater effect, such as orientation, location, shape and materials used. The statement of maximum building heights is therefore considered inappropriate for ILS safeguarding.

m. WHAT IS THE TOTAL ILS HINDRANCE CAUSED BY THE CIRCLE FREIGHT PLAN;

Simulation of the Circle Freight proposal indicates that the proposed development has almost no measurable effect on ILS glidepath performance.

n. WOULD THE CONSTRUCTION OF THIS SPECIFIC PROJECT LEAD TO DEGRADATION TO CAT I OF THE ILS;

No. It is unlikely that the effects of the development would be measurable.

2002/2003 BUILDING STOP

o. DOES THE CONSTRUCTION OF AREAS I AND IV CAUSE AN ADDITONAL DISTURBANCE OF 58.7%?

Modelling carried out by Cyrrus Associates has not substantiated the claimed disturbance. Additionally, it is considered that the percentage disturbance has been calculated incorrectly by arithmetic rather than vector addition.

p. WHAT ARE THE CONSEQUENCES IF THE ENTIRE PLAN AS REFERRED TO IN THE DRAWING ARE TO BE REALISED (AREAS I, III, IV AND V)?

Construction as planned is expected to lead to some disturbance to the ILS glidepath performance but this is expected to remain within acceptable levels. The level of disturbance can be minimised further by careful planning.

q. AFTER REALISATION OF THE PLANS THE REQUIREMENTS FOR CATEGORY II AND III ARE NO LONGER COMPLIED WITH LEADING TO THE DE CLASSIFICATION TO CATEGORY I.

IS THIS STATEMENT CORRECT?

Cyrrus Associates has found no evidence to support the claim that development of the GBT would result in the downgrading of the ILS from Cat III to Cat I.

r. WOULD THE ADDITIONAL DISTURBANCE CAUSED BY EXECUTION OF CHIPSHOL'S PLAN V.2002W813B01 of **October 29th 2002** LEAD TO DE-CLASSIFICATION OF THE ILS FROM CAT-III TO CAT-II OR CAT-I?

Cyrrus Associates has found no evidence to support the claim that development of the GBT would result in the downgrading of the ILS from Cat III to Cat I.

s. WOULD THE GLIDE PATH SIGNAL NO LONGER QUALIFY TO ICAO ANNEX 10 IN RESPECT OF CAT III LANDING OPERATIONS?

There is no evidence to support the claim that development of the GBT would result in the ILS glidepath no longer supporting Cat III landing operations.

LVNL USED AXIS SOFTWARE FOR ITS ASSESMENT.

t IS IT THEN IMMINENT THAT LVNL MUST HAVE KNOWN WHAT THE CAUSE FOR THE DISTURBANCE WAS IN 2003?

The causes of disturbance by buildings and the effect of orientation, size, location and the subsequent influence on the ILS are expressly stated in LVNL letter LVB 801038 of 16th November 1998. It is therefore reasonable to assume that the issues were well known to LVNL throughout this process.

u. Considering the garbage in garbage out principle could you recompile from that simulation what lvnl' s assumptions were and if so if those were correct considering a best practice effort?

The simulation was neither realistic nor worst-case. The simulation was not configured to accurately represent the scenario, and the presentation did not make clear what the major issues were. The simulation is only valid for a particular structure, located in a precise position, and at an exact orientation. From the evidence presented, no further conclusions can be made on the effect of other structures or actual development. Inexact configuration of the simulation also led to the results presented being exaggerated.

2005 NLR REPORT

v. IS THE ILS DISTURBANCE CAUSED BY PLAN V.2002W813B01 (INCLUDING TRUCK PARKING) IN EXCESS OF THE APPLICABLE LIMITS

Modelling and simulation carried out by Cyrrus Associates has not demonstrated that the development as planned would exceed LVNL tolerances or cause downgrading of the ILS facility performance category.

w. WAS THE REMAINING ILS HINDRANCE IN THE NLR REPORT CALCULATED CORRECTLY? IF NOT WHAT WAS THE CORRECT ILS HINDRANCE BUDGET?

It is considered that the treatment of remaining error budgets was incorrectly assessed. Of the 14.14µA total static error budget, LVNL had stated that 54.6% (7.72µA) was already used (from NLR report NLR-CR-2006-185). The remainder has been assessed by LVNL and NLR as 14.14µA - 7.72µA=6.42µA. Bends are a result of the vector addition of multipath components; it is normal practice to add vector quantities by Root Sum Squares method, not by straight arithmetic addition. In this case the remaining budget is 11.84µA not 6.42µA as stated by LVNL. The assessment of the plans submitted by Chipshol was therefore based on an erroneous assumption to the disadvantage of the developer.

x. IS DISTURBANCE CAUSED BY TRUCKS TO BE CONSIDERED AS STATIC OR DYNAMIC DISTURBANCE?

As the truck parking is variable, it raises the question as to whether this should be allocated to the static or dynamic budget. A reasonable resolution would be to allocate half of the potential disturbance to static bends and half to dynamic bends.

y. IF THE TRUCKS CAUSED EXCESS HINDRANCE WOULD THERE BE A (SIMPLE) SOLUTION TO SOLVE THIS?

The truck parking issue can be readily solved as illustrated in this report either by screening the trucks from the ILS glidepath with a suitable fence or structure, or by changing the orientation of the trucks.

VI. LIB

z IF YOU CONSIDER THE HEIGHT RESTRICTIONS UNDER THE LIB CAN YOU VALIDATE IF THOSE RESTRICTIONS ARE MANDATORY UNDER EITHER ICAO ANNEX 10 OR ANNEX 14.

The only mandatory height restrictions published by ICAO are the Obstacle Limitation Surfaces specified in Annex 14. The adoption of the Obstacle Limitation Surfaces is mandatory to ICAO member states. Other height restrictions, e.g. for safeguarded surfaces, are advisory, and not designed to prevent building development. The height restrictions quoted by LVNL do not appear to be derived from mandatory ICAO requirements.

aa DOES ICAO SET OUT ANY HEIGHT RESTRICTION IF SO IN WHAT ANNEX AND WHAT HEIGHT RESTRICTION

ICAO publishes Obstacle Limitation Surfaces for licensed aerodromes in Annex 14. These surfaces are designed to reduce the risk of aircraft collision with obstacles. The adoption of the Obstacle Limitation Surfaces is mandatory to ICAO member states.

ICAO issues guidance on safeguarding surfaces for technical facilities. These are not mandatory.

VII. General questions:

ab CONSIDERING THE ENTIRE OUTCOME AND THE CONDUCT OF LVNL FROM 1996 TO 2005 WOULD YOU CONSIDER LVNL' S CONDUCT A BEST PRACTICE CONDUCT;

From the evidence presented by Chipshol, LVNL has at best been over zealous in safeguarding the performance of the technical facilities that it is responsible for, and at worst been negligent in basing responses to planning applications on unrealistic scenarios and inaccurate assessments of data. Our conclusion is that the process cannot be considered best practice conduct.

ac DETERMINE THE LOCATION AND HEIGHT OF FUTURE DEVELOPMENTS OF AVAILABLE REAL-ESTATE ON GBT INCLUDING TRUCKPARKING. DETERMINE AREA WHERE NO DEVELOPMENTS CAN BE CONDUCTED

With careful design of buildings and layout, there should be little restriction on development of the GBT. The only area of the GBT where development could be restricted is within the Public Safety Zone area, although it is noted that the development to the west, opposite the GBT has been built in such an area.

9 References

1. ICAO Annex 10 – Aeronautical Telecommunications.
2. ICAO Annex 14 – Licensing of Aerodromes
3. ICAO EUR DOC 015 - European Guidance Material On Managing Building Restricted Areas
4. AXIS 330 Users Manual
5. UK Civil Aviation Authority Publication CAP 670
6. Netherlands Aeronautical Information Publication 26th October 2006.

Evaluation Tools Used

1. AXIS 330 Release 39
2. AXIS 110 Release 39a
3. AutoCAD 2004
4. PHX Tools v6.02

Data Used

1. Chipshol Drawing 'Farm Foot' (General scaled drawing of Schiphol area)
2. Chipshol Drawing GBT813bl01
3. Chipshol Drawing GBT817bl01
4. AIS Netherlands Aeronautical Information Package
5. NLR ATN Nooitgedagt Report NLR-CR-2005-113
6. NLR ATN Nooitgedagt Report NLR-CR-2006-185
7. LVNL Flight Inspection report 19-10-98
8. LVNL Letter LVB 800456 15th May 1998
9. LVNL Letter LVB 800482 28th May 1998
10. LVNL Letter LVB 800696 23rd July 1998
11. LVNL Letter LVB 801038 16th November 1998
12. LVNL Letter S&I/NAV 15513 6th June 2003

A Annex A – ILS Simulation Issues

A.1 Effects of Buildings on ILS Glidepaths

A.1.1 The effect that a building or construction will have on an ILS glidepath signal is dependant on many factors. Some of these factors are:

- Location
  - The position of the building relative to the antenna system will have a significant impact on the potential disturbance to the ILS signal. Buildings close to the path between the antenna and aircraft, and generally those closes to the antenna having a greater effect.
- Orientation
  - The orientation of a building will determine the directions in which radio energy will be reflected. Energy reflected towards aircraft on approach to the runway has the greatest effect.
- Size of building
  - The amount of reflected energy is proportional to the area of the reflecting faces of the building.
- Height of building
  - Generally, the greater the height, the greater the effect. This is especially the case for the ILS Localiser, but is also true to a significant but lesser extent for the glidepath.
- Building Material
  - The material from which a building is constructed has a great influence on the amount of energy reflected. Smooth metal is assumed to have a reflection coefficient of 1.0, i.e. all of the incident energy is reflected. Brick, glass and concrete have a reflection coefficient of around 0.5. As only half of the energy is reflected, the effects are also reduced by a similar amount.
- Building Surface
  - A flat surface will reflect energy in a similar way to a mirror. Highly irregular surfaces (relative to the radio wavelength) will scatter the energy much more widely and will have a much lesser effect on the ILS beam.
- Screening
  - Reflections and diffraction will only occur from aspects of the building illuminated by the ILS signal. Trees and dense vegetation can effectively ‘hide’ a building from ILS signals. Conversely, areas of water ahead of the building can theoretically magnify the effects.

A.1.2 The effect of orientation and height are demonstrated in the following diagrams.

A.2 Effects of building orientation on ILS Glidepaths

A.2.1 To demonstrate the effects of orientation, a smooth metal plate 100m long and 15m high, like a (very) large advertising hoarding, is placed at the GBT 150m from the glidepath centreline as shown in figure A1.

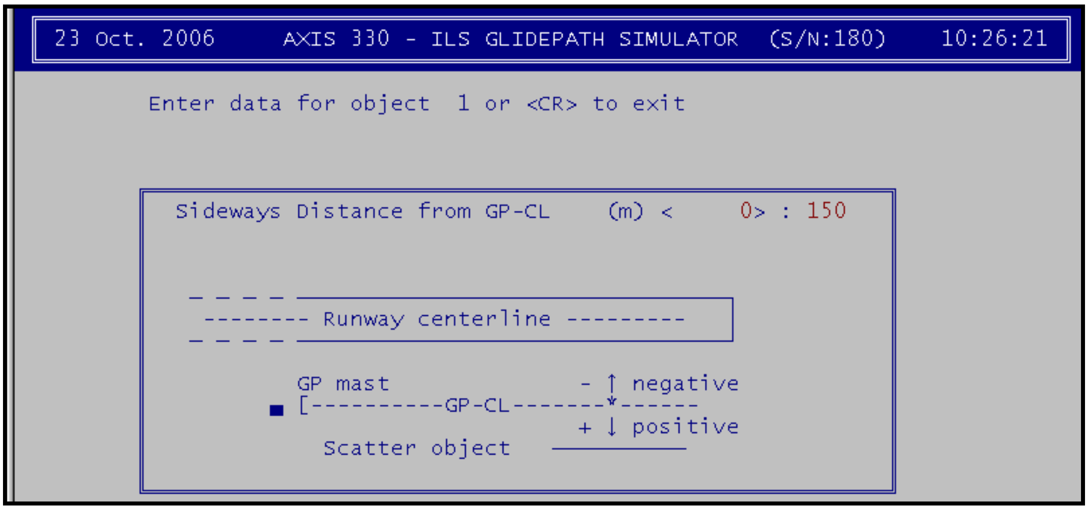


Figure A1. Test Configuration – Plate Position

A.2.2 The plate, illustrated by the thick magenta line in figure A3, is initially placed parallel to the runway, and then rotated in 5° increments to demonstrate the effects of orientation. The way this is entered into the model is shown at Figure A2.

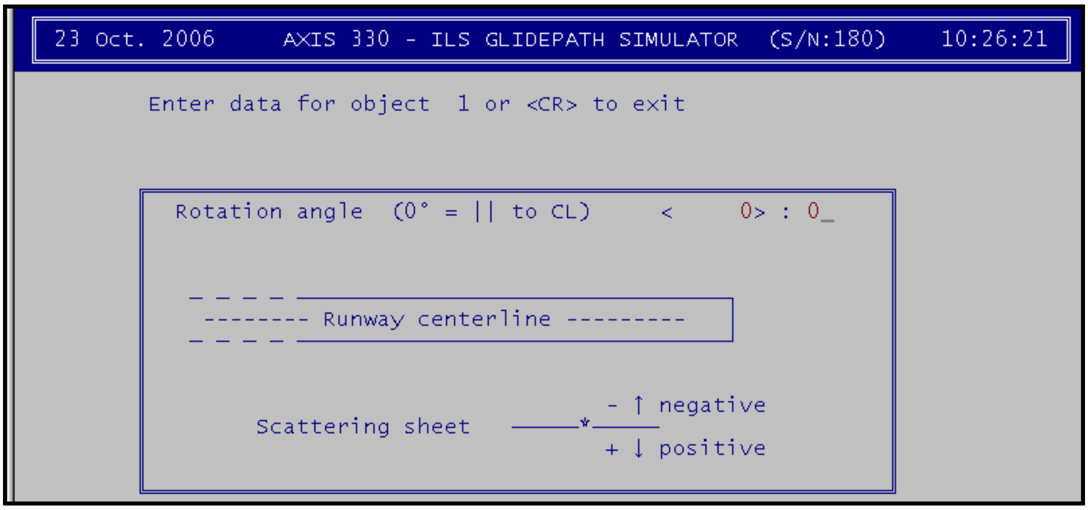


Figure A2. Test Configuration – Plate Rotation

A.2.3 A diagram illustrating the process is shown at Figure A3.

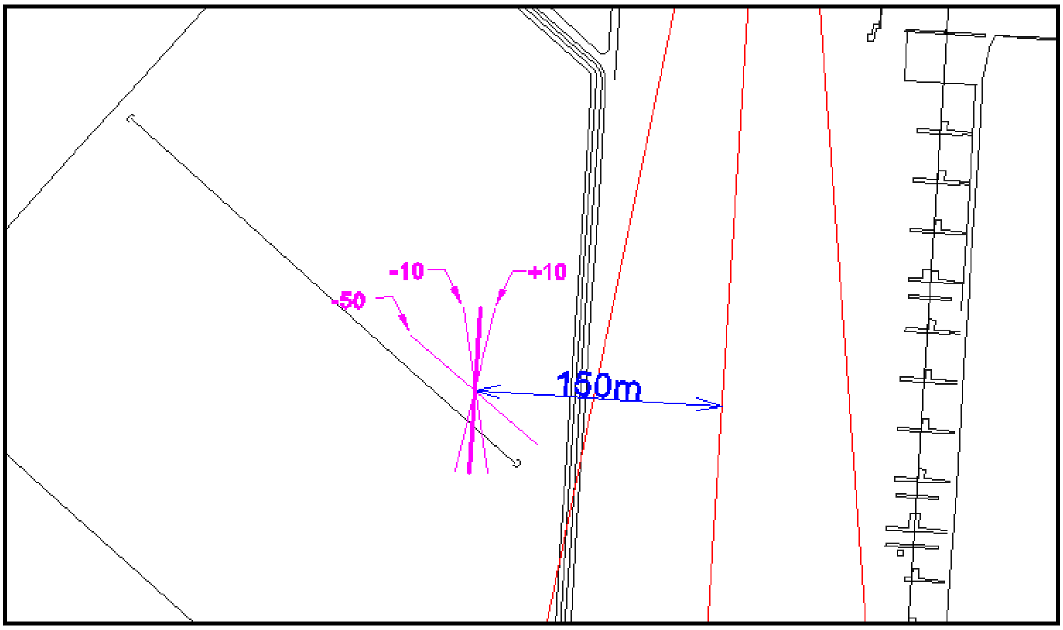


Figure A3. Theoretical location of test plate.

A.2.4 This appears in the model configuration as shown at Figure A4. The ILS configuration is the same as used for the simulation of Schiphol 36R.

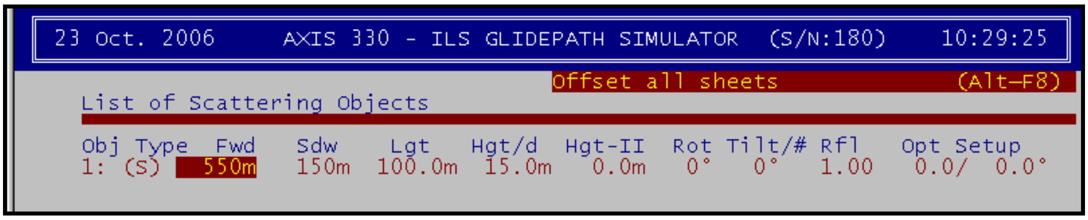


Figure A4. Model Configuration.

A.2.5 The approach course structure is now determined in 5° increments of plate rotation from +20° to -40°. The results are shown as a series of figures with comments.

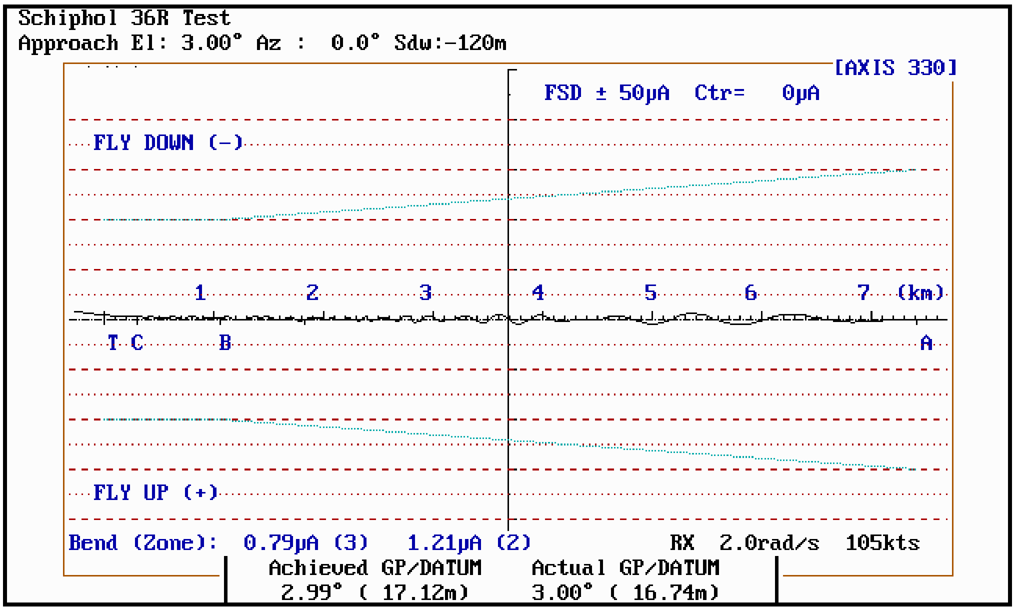


Figure A5. Plate at +15°
At this angle, the plate does not reflect the signal towards the aircraft

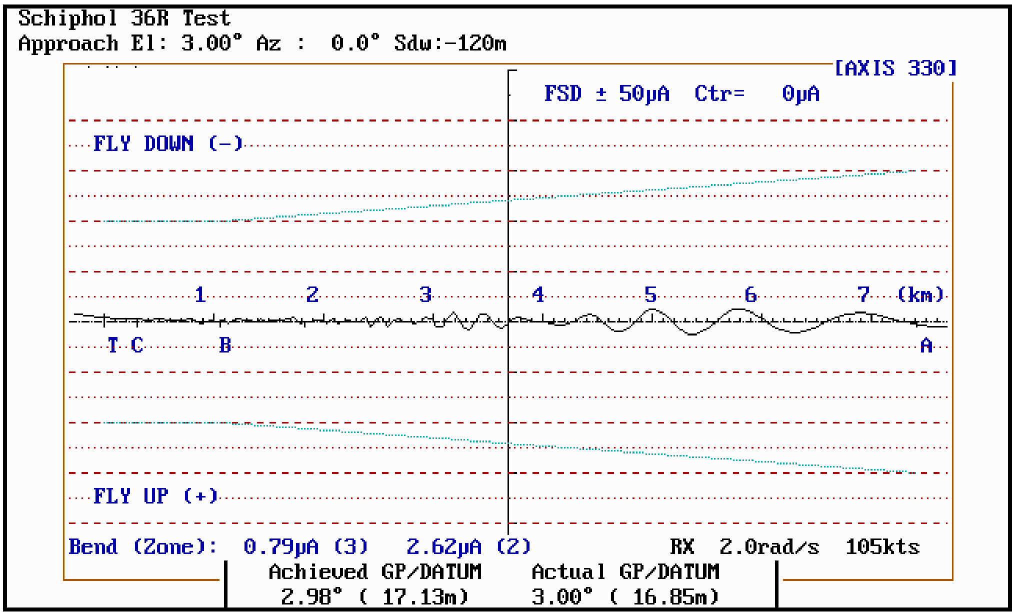


Figure A6. Plate at +10°
At this angle, the plate reflects very little signal towards the aircraft

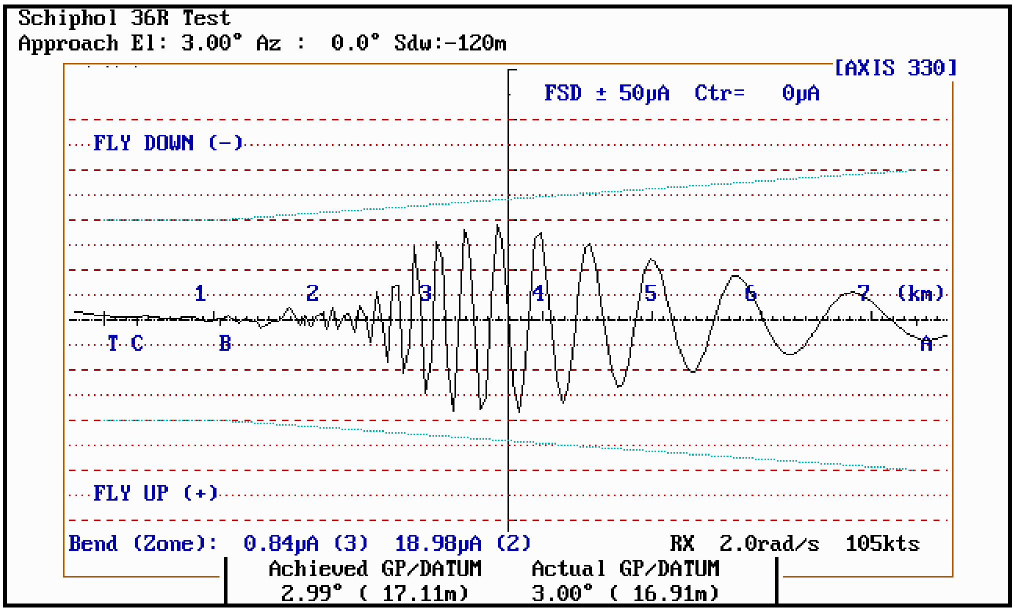


Figure A7. Plate at +5°
The energy is reflected directly to the aircraft on approach.

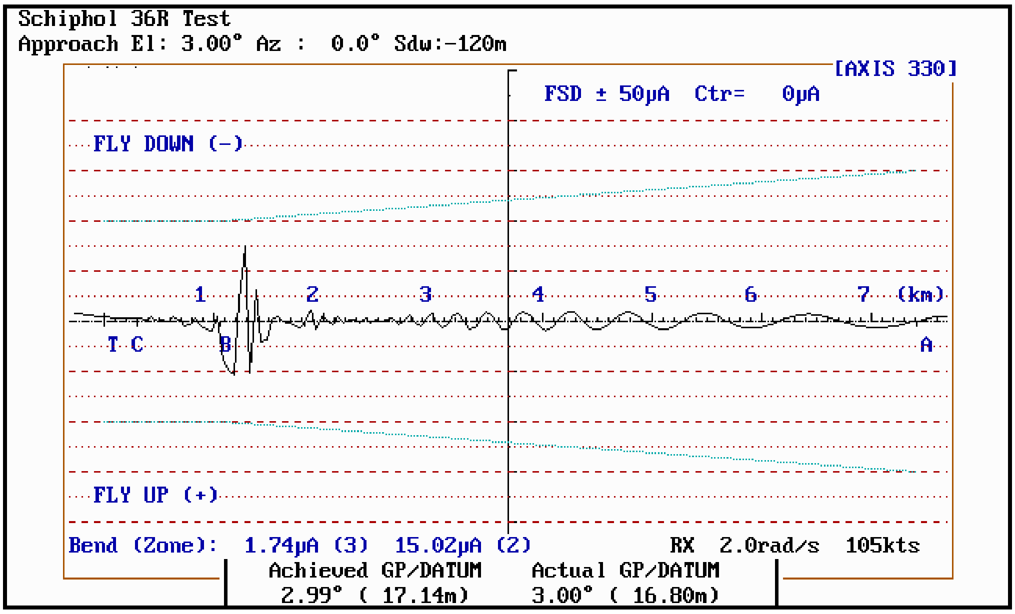


Figure A8. Plate at 0° (Parallel to runway)
The effects are quite localised as the plate acts as a mirror

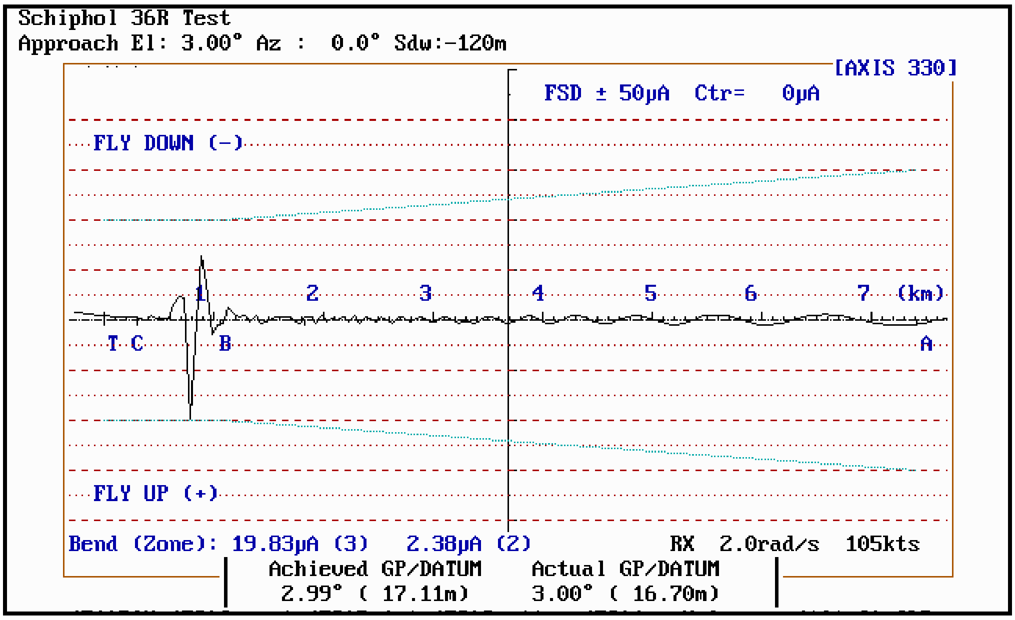


Figure A9. Plate at -5°

Reflections still affect the approach closer to the threshold.

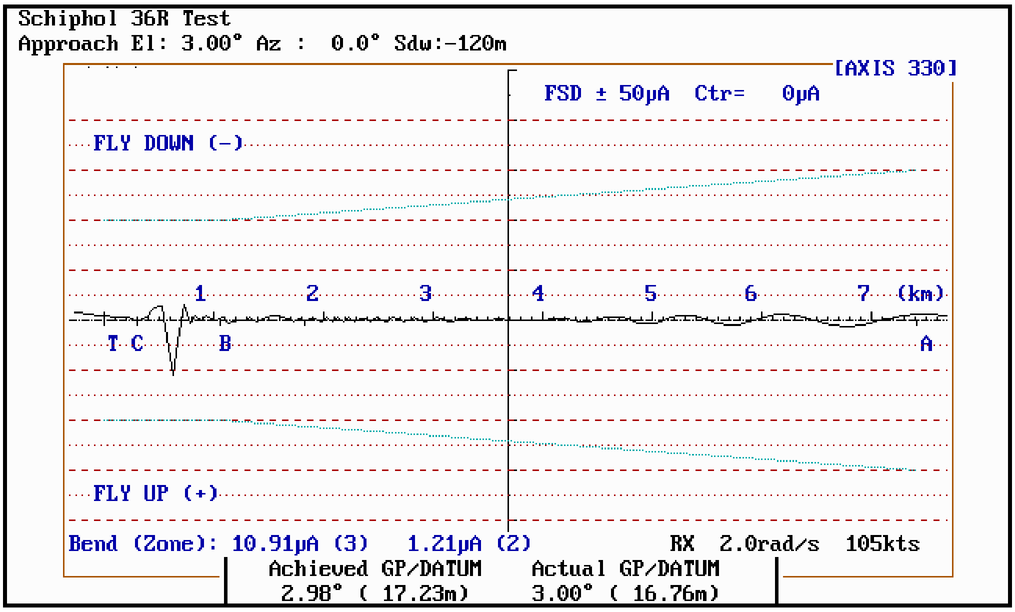


Figure A10. Plate at -10°

Reflections still affect the approach closer to the threshold.

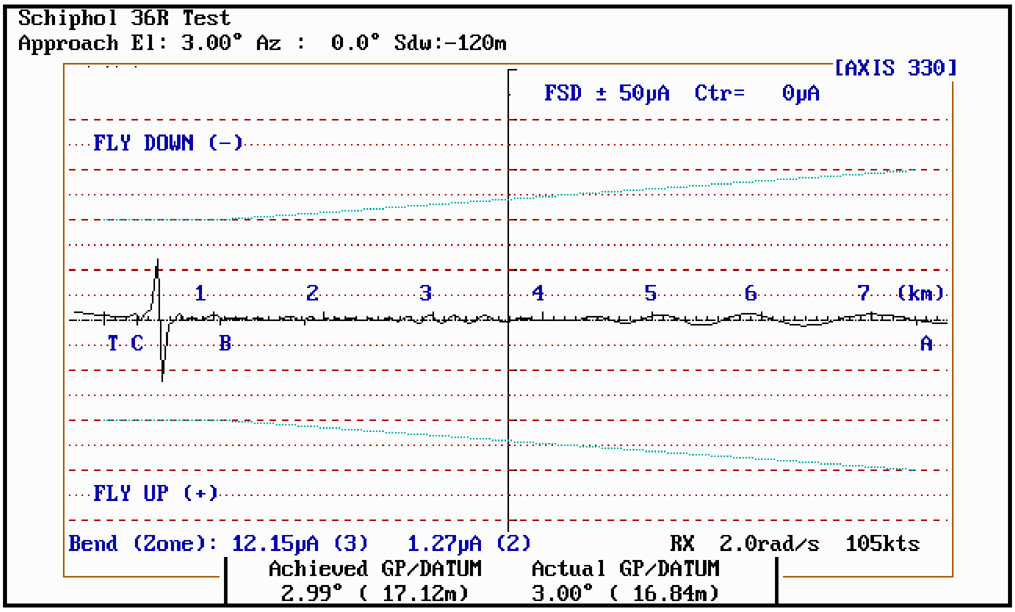


Figure A11. Plate at -15°
Reflections still affect the approach closer to the threshold.

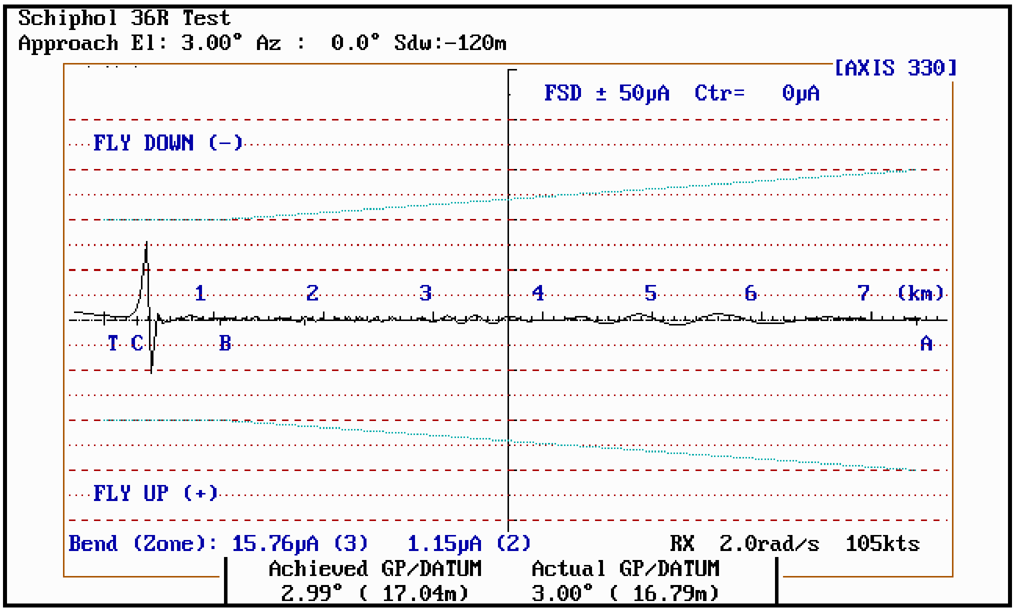


Figure A2. Plate at -20°
Reflections still affect the approach closer to the threshold.

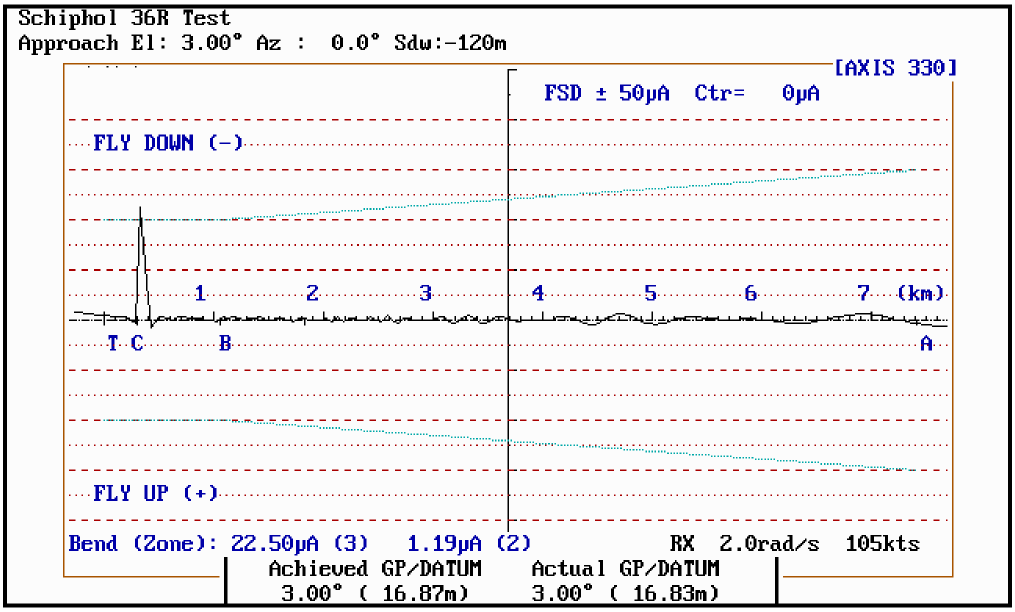


Figure A13. Plate at -25°

Reflections still affect the approach closer to the threshold.

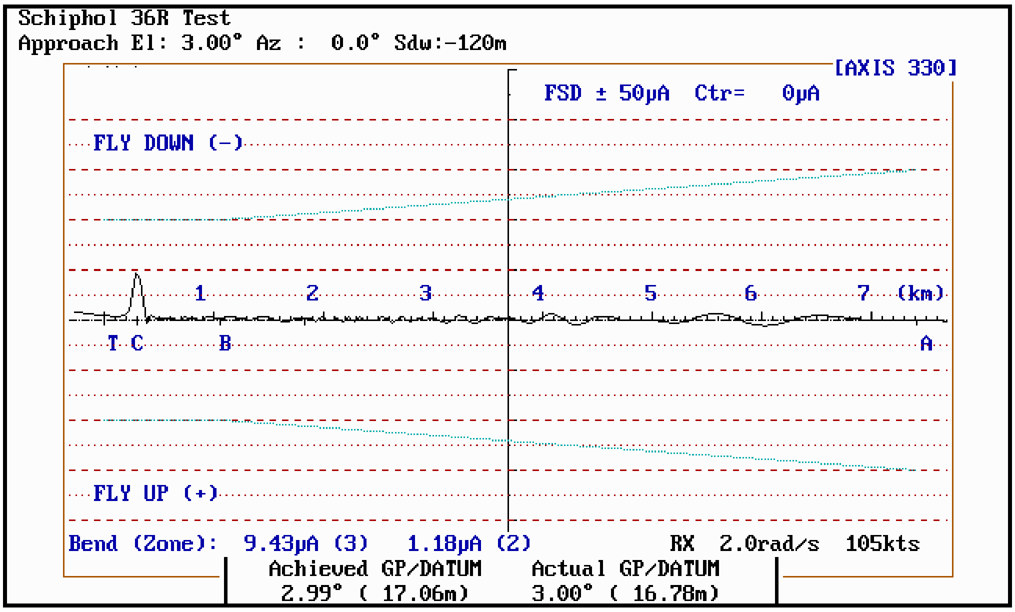


Figure A14. Plate at -30°

Reflections still affect the approach closer to the threshold – effects are reduced.

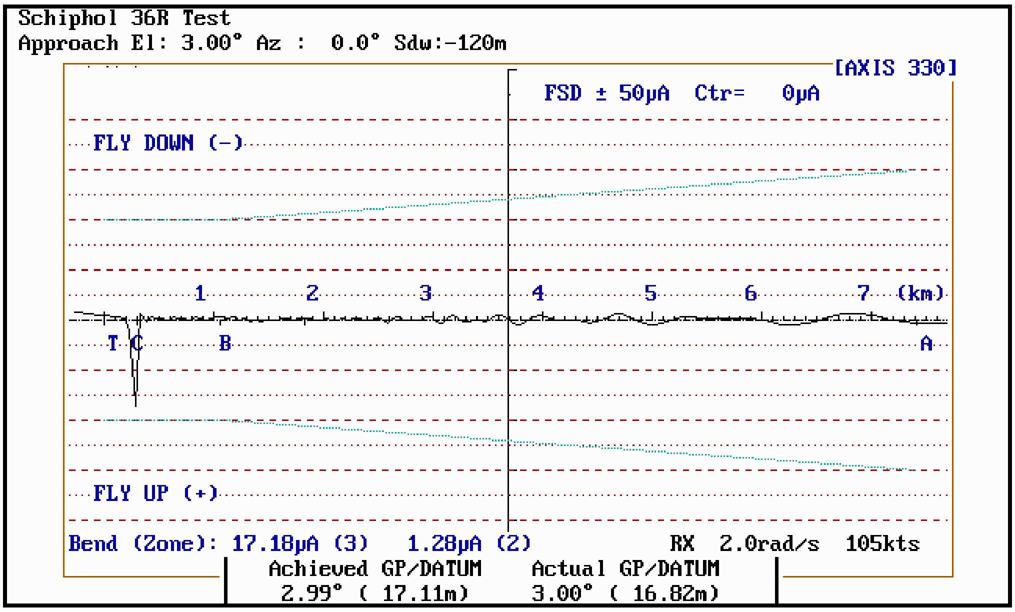


Figure A15. Plate at -35°

Reflections still affect the approach closer to the threshold.

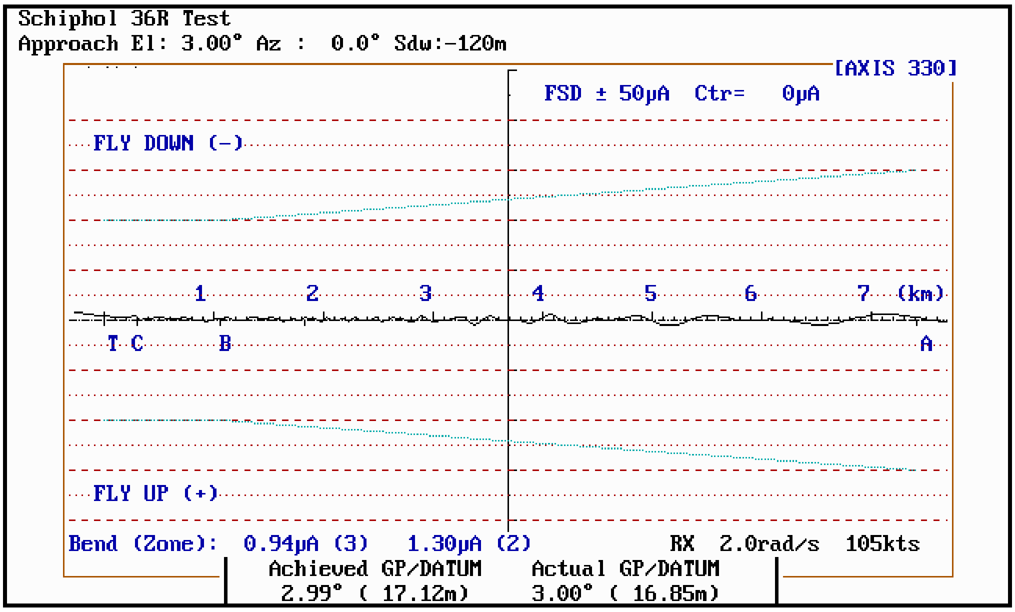


Figure A16. Plate at -40°

Effects become almost unmeasurable.

A.2.6 As can be seen, the effects of building rotation are significant. This demonstrates a change by a factor of 16 in the disturbance of approach course structure in ILS Zone 2.

A.3 Effects of building height on ILS Glidepaths

A.3.1 A similar test of the effect of building height is made by locating a 100m wide metal sheet of varying heights in a fixed position. The position is the same as the previous test, and the orientation fixed at 50°, which is close to the orientation of the planned GBT development. Model configuration and results are shown in the following figures.

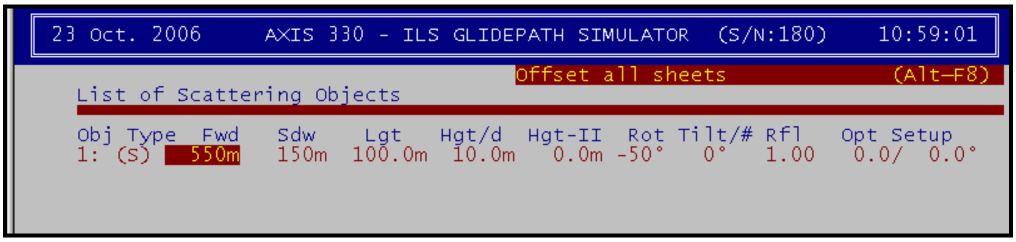


Figure A16. Height test model

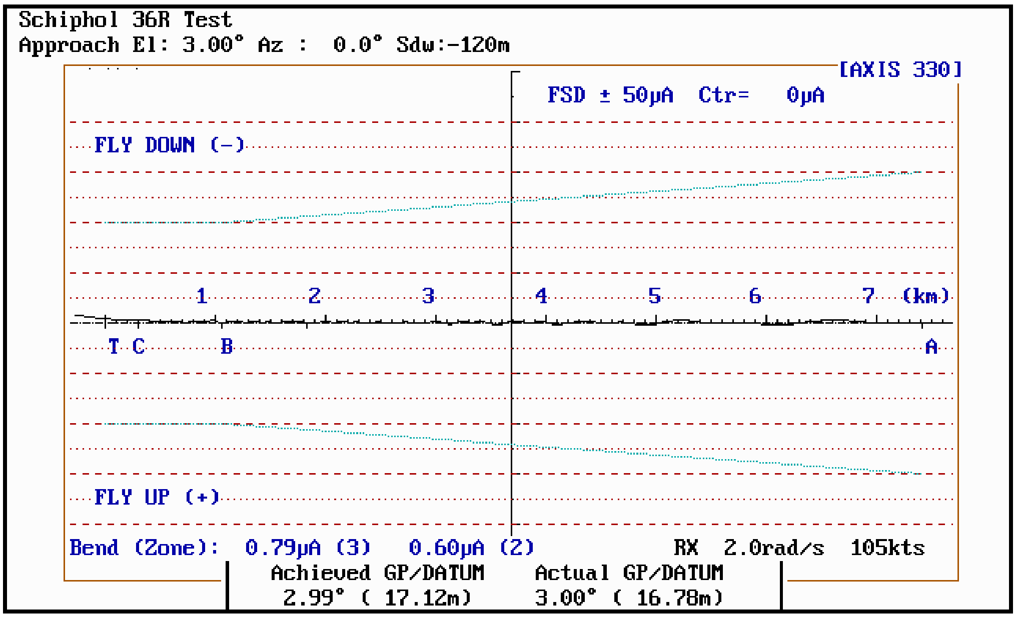


Figure A17. 10m high

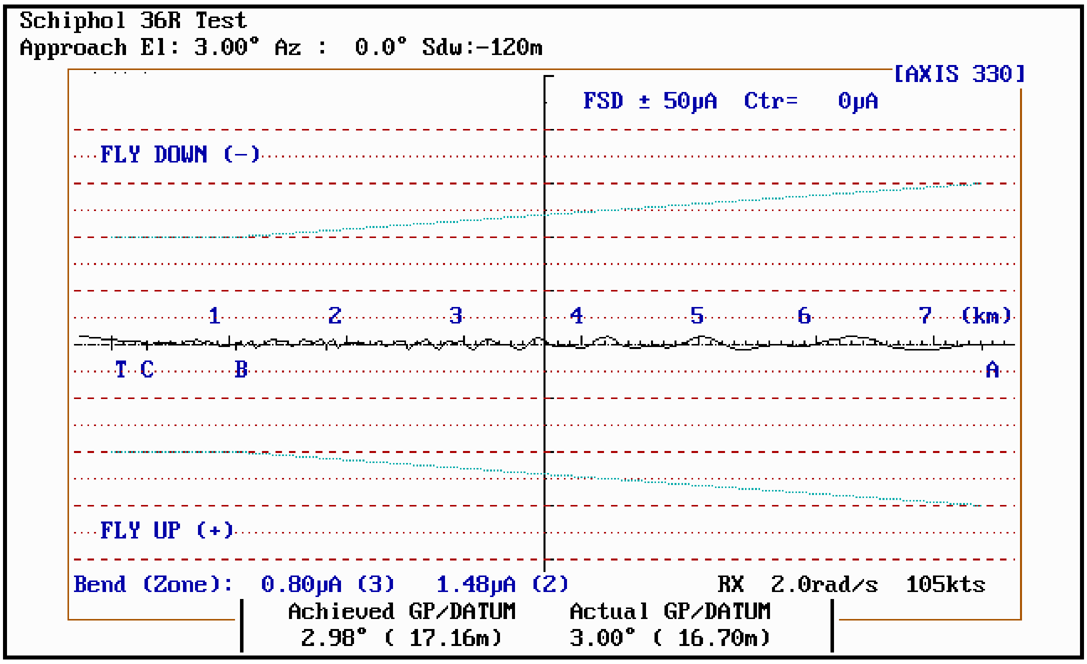


Figure A18. 20m high

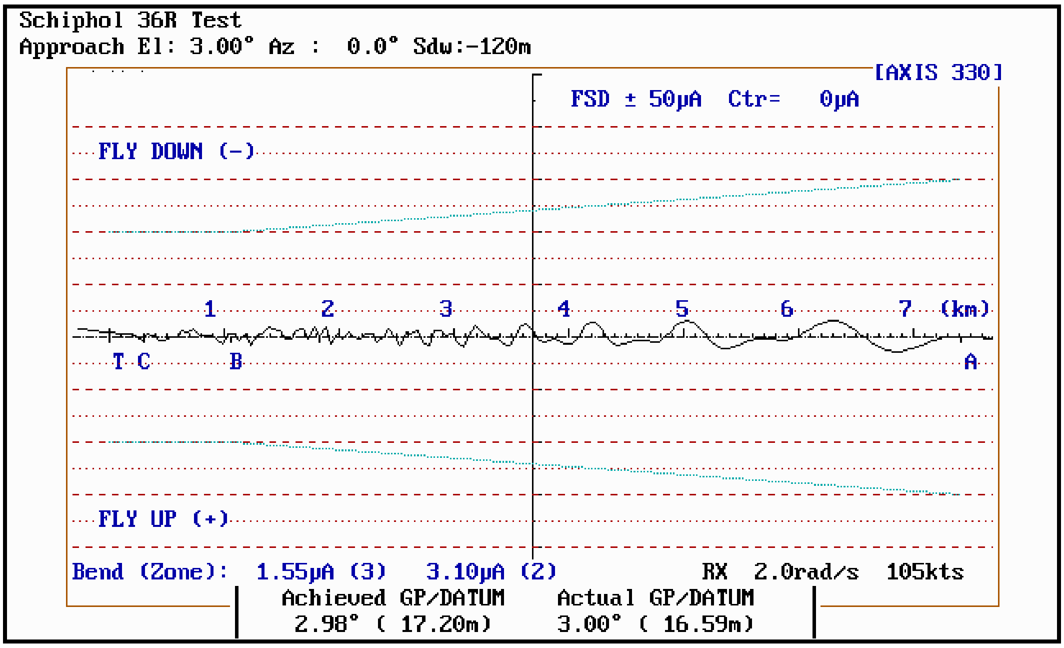


Figure A19. 30m high

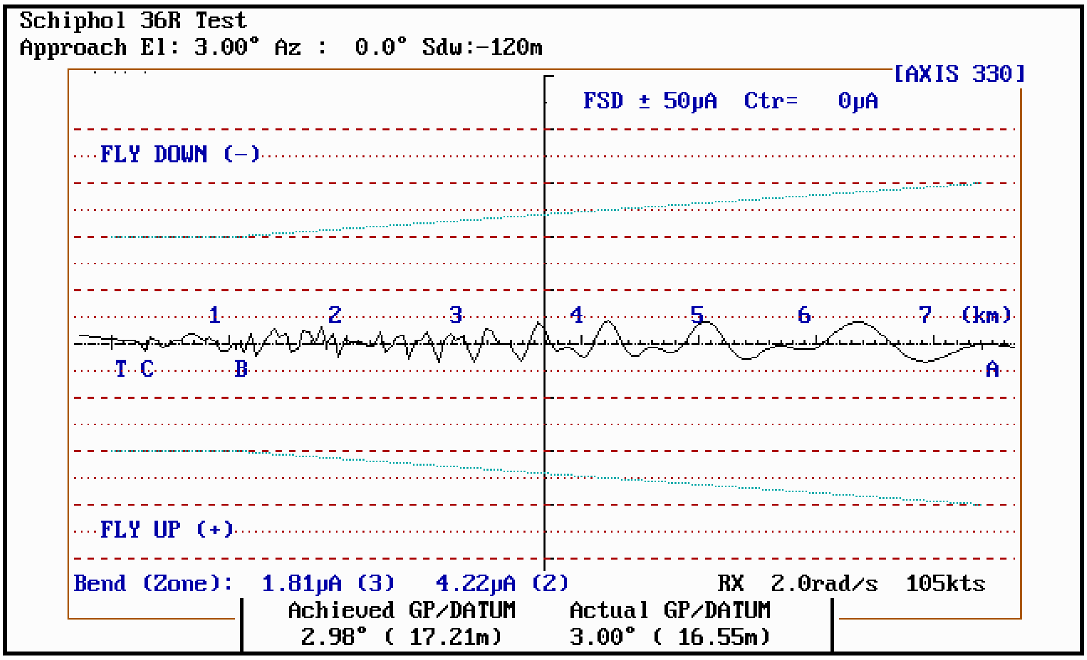


Figure A20. 40m high

A.3.2 At this orientation, most of the effects come from edge diffraction rather than reflected signal. In theory, a 40m high by 100m wide smooth metal plate could be placed on the GBT at the location indicated and not have an excessive effect on the glidepath structure. The effect on the glidepath coverage is illustrated at Figure A21.

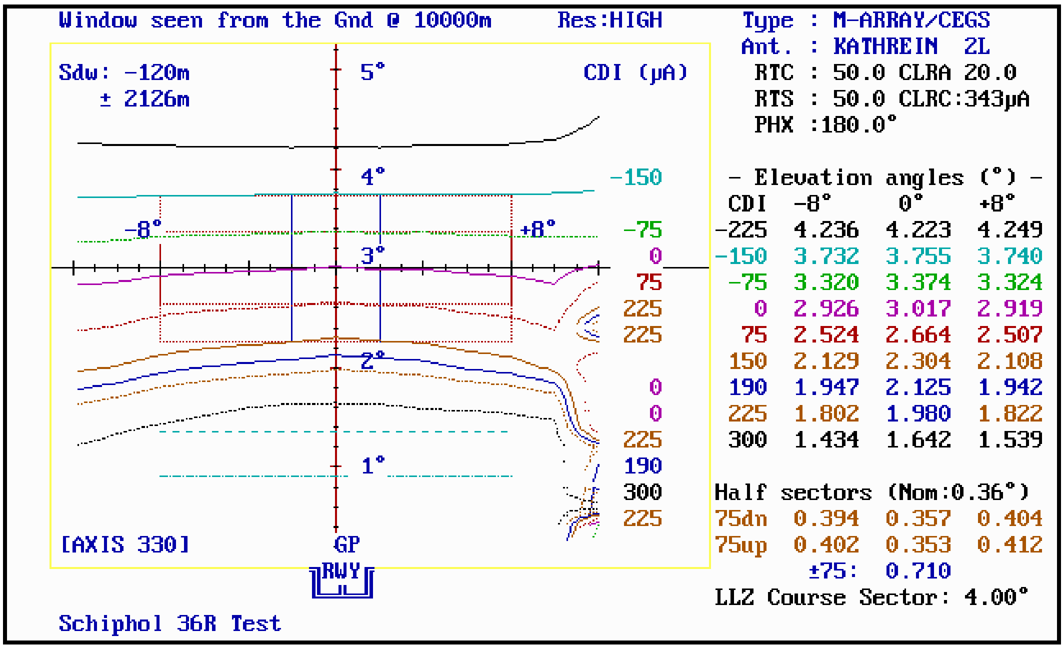


Figure A21. Glidepath Window Overview - 40m high building.

A.3.3 Although there is some distortion evident, it is outside of the glidepath lateral coverage limits (±8°) and therefore acceptable.

B Annex B

B.1 Other Considerations

B.1.1 The scope of this report is limited to the effects of development of the GBT on the ILS glidepath system; however there are other Communication, Navigation and Surveillance systems that may need to be considered. Some of these systems are considered in this section. These examples are illustrative, not a comprehensive list.

B.2 ILS Localiser

B.2.1 The ILS Localiser provides lateral approach and landing guidance to aircraft. In many respects it is the most critical part of the autoland system. The Localiser works in the same way as the ILS glidepath and is subject to multipath reflections from buildings and objects by the same mechanisms. The much wider azimuth coverage (±35°) makes it much more prone to degradation from reflections.

Figure B1. Localiser Considerations.

B.2.2 The current ILS localiser is located 3642 metres beyond the runway 36 threshold on the extended runway centreline. As with the glidepath, the main concern is with reflections from flat faces of buildings. The oil storage tanks to the north offer some shielding of the GBT. In Figure B1, development to the left of the red line is screened from the ILS localiser. Development to the right of the red line will require careful planning to ensure localiser performance is not compromised.

B.2.3 To assess the magnitude of the localiser issues, a 10m tall building was modelled at Area B and the results quickly assessed using AXIS 110. The result is shown at Figure B2.

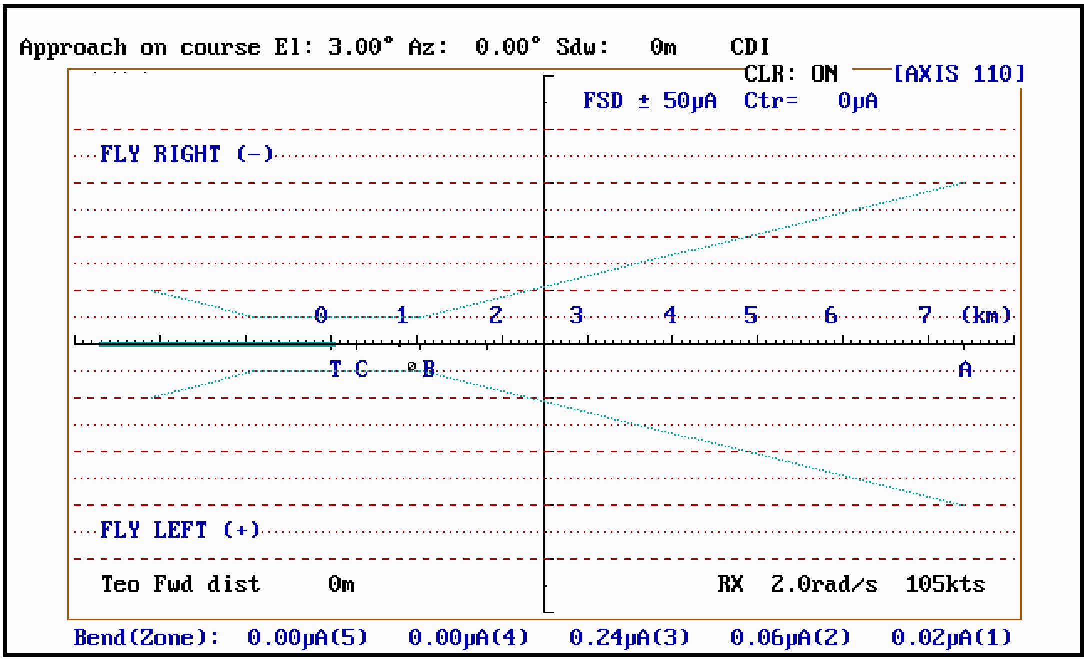


Figure B2. Localiser Course structure – 10m building at area B

B.2.4 The simulation shows that a 10m building at area B has virtually no effect on the localiser (*Normarc 24 Element dual frequency*).

B.3 MLS Elevation

B.3.1 The MLS elevation provides a similar service to the ILS glidepath, but uses different technology. It is not in common use, and only deployed where special needs require it. The number of aircraft equipped to use MLS is very small.

B.3.2 The area required to protect the Operational Service Volume for straight in approach and landing (not RNAV) is contained within a ±10° sector around the centreline. This is illustrated in Figure B3.

Figure B3. MLS Elevation

B.3.3 The area contained within the blue shaded area covers ±10° in azimuth from the MLS Elevation transmitter. This is clear of proposed developments of the GBT.

B.4 Radar

B.4.1 It is a normal operational requirement to maintain radar surveillance of aircraft throughout approach and landing. Tall buildings can create shadows which reduce the radar probability of detection.

B.4.2 The positions of the radar sensors are not known, but the planned development of the GBT is unlikely to be a problem in this area. Landing aircraft will cross the runway threshold at 16m, with a descent path of 52m/Km.

C Annex C - Credentials

C.1 Cyrrus Associates

C.1.1 Cyrrus Associates Limited is a company that provides consultation and services for Communication Navigation and Surveillance/Air Traffic Management (CNS/ATM) issues and has provided advice to a number of airport operators and aviation authorities on airspace matters throughout Europe since 1999. One of its core competencies is the activity known as safeguarding. The Company has undertaken several airport navigation systems safeguarding tasks in the UK and Ireland. Work has been undertaken at the following major airports: Bournemouth, Bristol Filton, Coventry, Cranfield, Exeter, Jersey, Leeds Bradford, London Heathrow and Robin Hood – Doncaster Sheffield.

C.1.2 The Company has a contract to undertake safeguarding tasks related to UK enroute surveillance radars and also has an enviable success in brokering the installation of wind turbine development in the vicinity of airports and air navigation systems.

C.2 Team experience

C.2.1 Cyrrus Associates is ideally suited to the completion of this investigative study as the consultants have:

- Recognised qualifications in ATC Systems Engineering and operational experience in ATC matters;
- Received formal training in the use of AXIS;
- An excellent knowledge of ICAO Annex 10 and 14;
- A proven track record for conducting detailed analysis of ILS systems and presenting the findings in a concise and understandable way;
- Worked to International, European and National standards according to the regulatory requirement in the country where the task is required;
- Experience of delivering quality results to demanding timescales;
- Excellent command of the English language both written and spoken.

C.3 Personnel

C.3.1 The curriculum vitae of the key staff involved in this project are shown at Annex A. Short pen pictures are provided below.

C.3.2 **Martyn Wills**: An effective and experienced Air Traffic Engineer, Martyn has gained extensive knowledge in the area of Radio Navigation, Aircraft and Airport Operations much obtained during his 16 years aircrew experience with the flight checking industry. Martyn has written and presented several technical papers in international forums and has acted in a consultancy role for several organisations including DGON, CAA Safety Regulation Group, Eurocontrol, NATS, and several UK airports. He has led technical research, sponsored by UK CAA, in several areas of radio navigation aids most notably the effects of phase modulation on ILS glidepath.

Martyn is a trained surveyor and has completed more than a dozen safeguarding tasks on airport navigational equipment in the last 2 years.

C.3.3 **Barry Hawkins**: Barry Hawkins is an effective, highly-motivated and experienced Air Traffic Control Officer (ATCO) who has had extensive operational experience at airfields at a middle management level. Prior to entering the consultancy field, he worked in the UK CAA Headquarters in airspace policy and regulation for 5 years. He has developed wide-ranging knowledge in airfield management including flight safety and impact of air operations on the environment. He was trained at the Singapore Aviation Academy in 1999 in ICAO PANS-OPS procedures design. He project managed the introduction of the revised airspace arrangements at Athens including radar vectoring charts for the TMA, 16 IAPs for Athens and the operational procedures. In addition, he co-authored a Regulatory Framework document which enabled the Hellenic CAA to license Eleftherios Venizelos Airport. He has used ICAO Annex 14 and the UK derivative enshrined in CAP 168 on several occasions to safeguard operations at UK regional airports.

C.4 Relevant Experience

C.4.1 General

C.4.1.1 The Team has accumulated a vast amount of experience in the safeguarding discipline. Indeed, Cyrrus has undertaken more than a dozen airport and surveillance radar safeguarding tasks in the last 2 years. Some of the work completed is explained in subsequent paragraphs.

C.4.2 Bristol Filton Airport

C.4.2.1 Bristol Filton is surrounded by industrial sites which are in a process of continuous development. Industry at the airport contributes to the development of the Airbus 380 and it is intended that this large aircraft should visit the airport during its development programme. Although the aircraft is able to land and manoeuvre off the runway, finding a location to park the A380 and ensure that the ILS is not adversely affected was a challenge. Using AXIS and detailed mapping, Cyrrus was able to advise the airport operations exactly where the aircraft could be parked so that routine operations were not disrupted.

C.4.2.2 Cyrrus Associates provided ILS modelling and safeguarding advice for the proposed new Aviation Museum designed to house a Concorde that was manufactured at Filton. Building siting and orientation is optimised to reduce effects on the ILS.

C.4.2.3 Cyrrus Associates provided ILS modelling and safeguarding advice for the development of industrial units ahead of the ILS Glidepath. Initially, the proposed development was unacceptable in terms of effects on ILS performance. By a combination of upgrading and reconfiguring the glidepath transmitting equipment together with optimisation of the building design, the ongoing safe performance of the ILS facility was assured.

C.4.2.4 ILS modelling has been provided to Airbus UK for several building developments on the factory site adjacent to the airfield.

C.4.3 London Heathrow – Annex to World Cargo Centre

C.4.3.1 Although London Heathrow is already highly populated with building development in support of the air operation, all additional building has to be assessed to ensure that it does not interfere with the airport surveillance radar. Using modelling software, the design of the building was tested to establish the potential effect on the radar. Having determined the impact, mitigation was suggested and tested by the radar system operators. The resolution was found to be appropriate and mitigation effective. The roof of the building was modified as recommended and planning approval obtained.

C.4.4 Coventry International Airport

C.4.4.1 Coventry is a regional airport which has development plans in place to establish an operation capable of handling 2mppa. However, there is not a lot of real estate available for development and what there is has to be used effectively. Cyrrus was engaged to undertake ILS modelling for new passenger terminal prior to the planning application. More recently, Cyrrus has undertaken ILS modelling and safeguarding for new car parks and new fuel farm plus relocation of comms facilities.

C.4.5 Leeds Bradford International Airport

C.4.5.1 To enable this thriving UK regional airport to optimise its operations, Cyrrus Associates and a partner company undertook a review of the current conventional procedures and the touchdown points for the ILS on both runways. The procedures were checked on various threshold/glidepaths positions to achieve an optimum design for either end of the runway. At the same time AXIS software was used to determine the location of the glidepath equipment which accorded with regulatory requirements whilst ensuring that the costs of ground renovation was kept to the minimum necessary. The methodology employed will assure maximum effective use of the runway commensurate with the local environment and airspace arrangements.

C.4.6 Jersey

C.4.6.1 Specification and project management of ILS procurement and installation of two ILS/DME systems.

C.4.6.2 Establish the ILS critical and safeguarded areas for Thales ILS installed at either end of the runway. The results were processed as highly quality scaled maps so that staff could be briefed on driving regulations on the airfield. In addition the maps were used in conjunction with an Annex 14 investigation to establish where building development could take place.

C.4.6.3 ILS safeguarding and modelling tasks for new fire training ground, new security fences and GSM masts.

C.4.6.4 Training of airport technical staff in the understanding and interpretation of flight inspection data.

C.4.7 Robin Hood airport – Doncaster Sheffield.

C.4.7.1 Feasibility study for upgrade of ILS facilities from Cat I to Cat III

C.4.7.2 Design of ILS configuration to support Cat III operations on Runway 20.

C.4.7.3 Design and specification of ILS configuration to support Cat I operations to runway 02.

C.4.7.4 Production of radar technical specification for 10cm Primary Surveillance radar

C.4.8 Cranfield Airport

C.4.8.1 ILS safeguarding study for the development of housing and business units on land owned by the airport.

C.4.8.2 VOR/DME safeguarding study for the development of housing and business units on land owned by the airport.

C.4.9 Blackpool Airport

C.4.9.1 ILS and operational safeguarding of new business park being developed on the airfield.

C.4.10 Enroute Radar

C.4.10.1 National Air Traffic Services (NATS) Ltd provides the air traffic services in all of the UK civil airways system. To ensure continuity of this service, a programme to replace all of the aging radar with current Raytheon products is in progress. There are 26 systems to be replaced with 6 of them completed already. Cyrrus was engaged to undertake an obstacle survey at each site and develop safeguard mapping which is used by Local Planning Authorities in consideration of planning applications within 5km of the navigational aid. The methodology employed and the results delivered to date have impressed the client and it is intended that Cyrrus will be engaged to complete the remaining sites in the coming years.

C.4.11 Wind Energy Safeguarding

C.4.11.1 The effects of wind turbine development on air navigation systems are well known in the CNS/ATM industry. Cyrrus has been instrumental in developing objective-based safeguarding criteria for assessing wind farm applications in the vicinity of airports and their navigation systems. Work has been completed for the Department of Trade and Industry, local regional governments, wind developers and airport operators. The impartial independent views expressed by Cyrrus have benefited all stakeholders involved in the difficult issue of integrating the needs of both industries.