

Aviation Impact Assessment

Amazon Site 1-2 Manchester

Zetec Asset Management Ltd.

May 2021

PLANNING SOLUTIONS FOR:

- Solar
- Telecoms
- Railways
- Defence
- Buildings
- Wind
- Airports
- Radar
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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	May 2021	Initial issue
2	May 2021	Second issue – minor amendments

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to undertake an aviation impact assessment with respect to a proposed rooftop solar panel development located on the Amazon Storage Centre located near Manchester Airport, Manchester, UK. The rooftop proposed development will be located approximately 900m north-west of the ATC Tower at the airport and within the area safeguarded by Manchester Airport. This assessment pertains to the possible effects upon aviation operations.

Development Overview

Solar panels will be fitted to the roof of an existing commercial unit. They will be mounted at the same pitch as the roof (6 degrees) and be orientated at 135 and 315 degrees. The solar panels will be mounted at a height between approximately 16.27m and 18.25m above ground level and no higher than the existing commercial unit.

Analysis Results

The proposed development will consist of low-lying rooftop solar panels mounted to the angled roof of an already constructed large commercial unit. There are no known safeguarding issues surrounding the existing commercial unit¹.

The relevant navigation aids (Distance Measuring Equipment – DME, and VHF omnidirectional range – VOR) have been assessed with respect to the associated International Civil Aviation Organization's (ICAO) Building Restricted Areas (BRA) and Civil Aviation Publication (CAP) 670 safeguarding criteria. No infringement of the surfaces associated with either safeguarding criteria has been calculated. No significant impact upon the DMEs or VOR is therefore predicted.

The proposed solar development will be in line of sight to the Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR), both of which are located to the south of the airport. The solar panels will cover a rooftop which is visible to both radar. The proposed development will also lie below the horizontal relative to the radar. On the basis of no pre-existing issues surrounding this rooftop causing reflections or shadowing effects, the proposed development will likely produce a negligible change over the baseline conditions.

The proposed development will not increase the height of the building however, for completeness, an OLS assessment was completed. The analysis showed that the solar panels (and the building) would have a minimum clearance of 18.5m from the IHS. Therefore no physical safeguarding issues exist.

¹ To the authors knowledge and as indicated through the analysis in this report.

Overall Conclusion and Recommendations

The proposed rooftop solar development will produce a negligible change to the baseline condition already present due to the presence of the commercial unit.

This report should be shared with the safeguarding team at Manchester Airport.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 50 countries within South Africa, Europe, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to undertake an aviation impact assessment with respect to a proposed rooftop solar panel development located on the existing Amazon Storage Centre² located near Manchester Airport, Manchester, UK. The rooftop proposed development will be located approximately 900m north-west of the ATC Tower at the airport and within the area safeguarded by Manchester Airport. This assessment pertains to the possible effects upon aviation operations. In detail, the report includes:

- Proposed development details;
- Summary of relevant guidance;
- Airport, navigation aid and radar details;
- Consideration of Building Restricted Areas (BRAs) in line with ICAO guidance;
- Consideration of CAP guidance;
- Radar line of sight for key aviation infrastructure and review of additional screening;
- Assessment of impact upon radar including high-level shadowing and reflection analysis;
- Obstacle Limitation Surfaces (high-level assessment);

Following the technical analysis, overall conclusions and recommendations are presented.

This report is entirely desk-based. No site visit has been undertaken.

² Referred to as 'existing commercial unit' throughout this report.

2 PROPOSED DEVELOPMENT LOCATION AND DETAILS

2.1 Existing Commercial Unit

Figure 1³ below shows the roof design side elevation of the existing commercial unit. The pitch of the roof is six degrees.

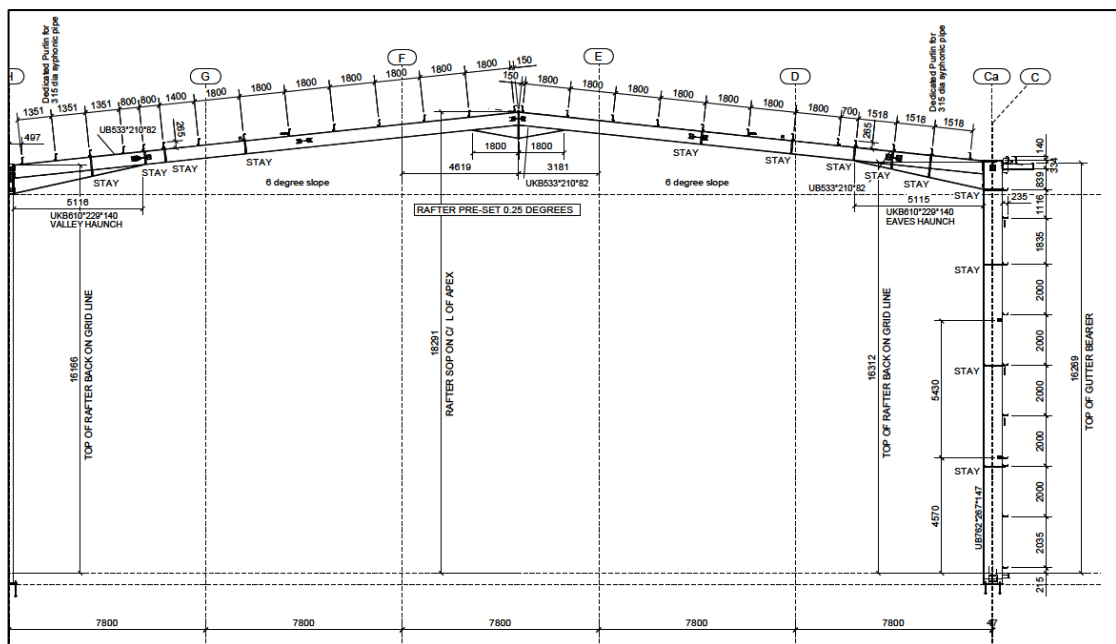


Figure 1 Side elevation of the existing commercial unit

³ Source: MAN1 - GA011 - Building Height and Roof Slope.

Figure 2⁴ below shows the north east, south east and south west side elevations of the existing commercial unit. These are the elevations that are positioned towards Manchester Airport.

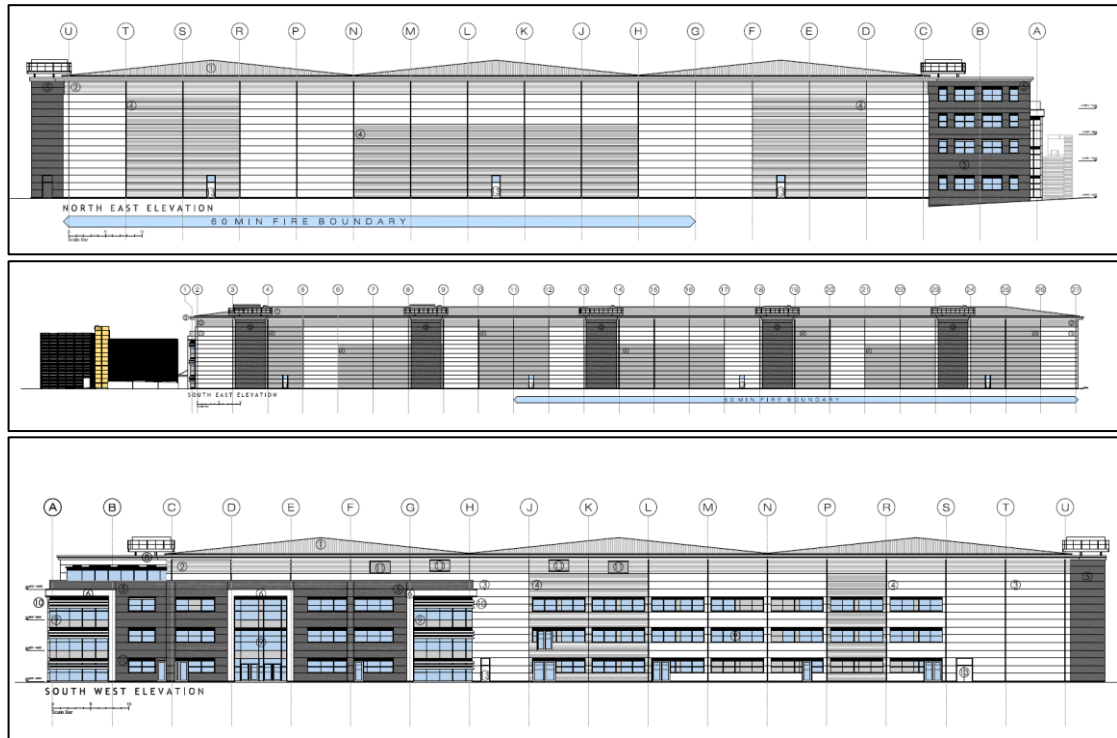


Figure 2 Side elevations of the existing commercial unit

⁴ Source: MAN1 - 8351-C-204 Rev C Building Elevations.

Figure 3⁵ below shows a Google Earth 3D visualisation of the existing commercial unit.



Figure 3 Google Earth 3D image of the existing commercial unit

⁵ Source: Copyright © 2021 Google.

2.2 Proposed Development – Proposed Solar Panel Area

The proposed rooftop solar panel development layout is shown in Figure 4⁶ below.

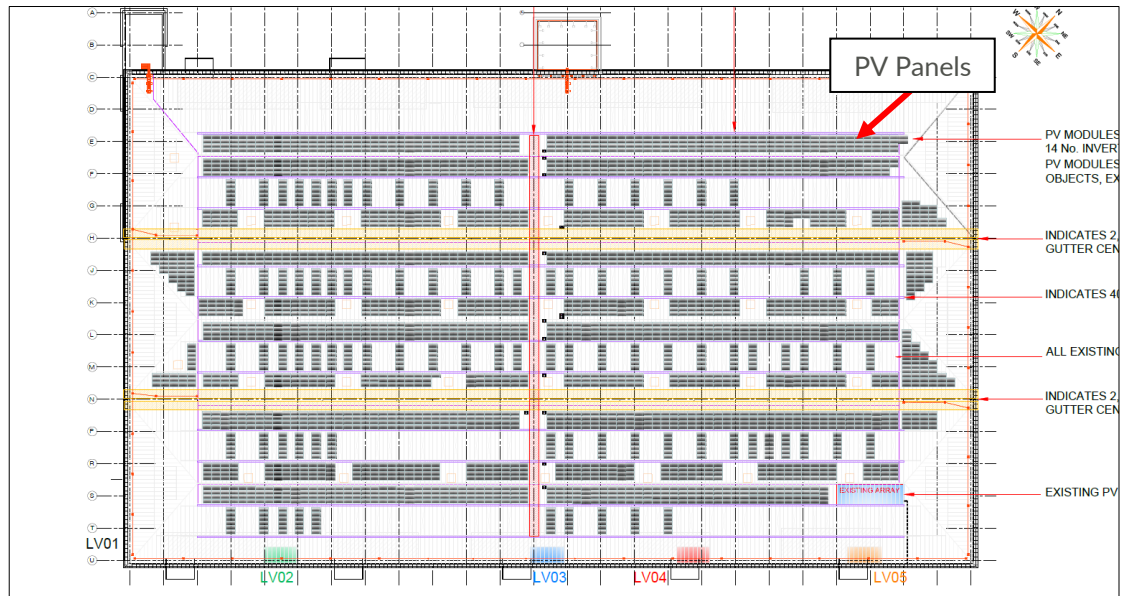


Figure 4 Proposed rooftop solar panel development

⁶ Source: PV ROOF PLAN ~ 1,515.15kWp SYSTEM, SAS Energy, date: 01/04/2021, Drawing No.: MAN1_M20_LAY_PV ROOF LAYOUT_C2

The proposed rooftop solar panel development consists of 12 distinct solar panel. Their locations are shown in Figure 5⁷ below.

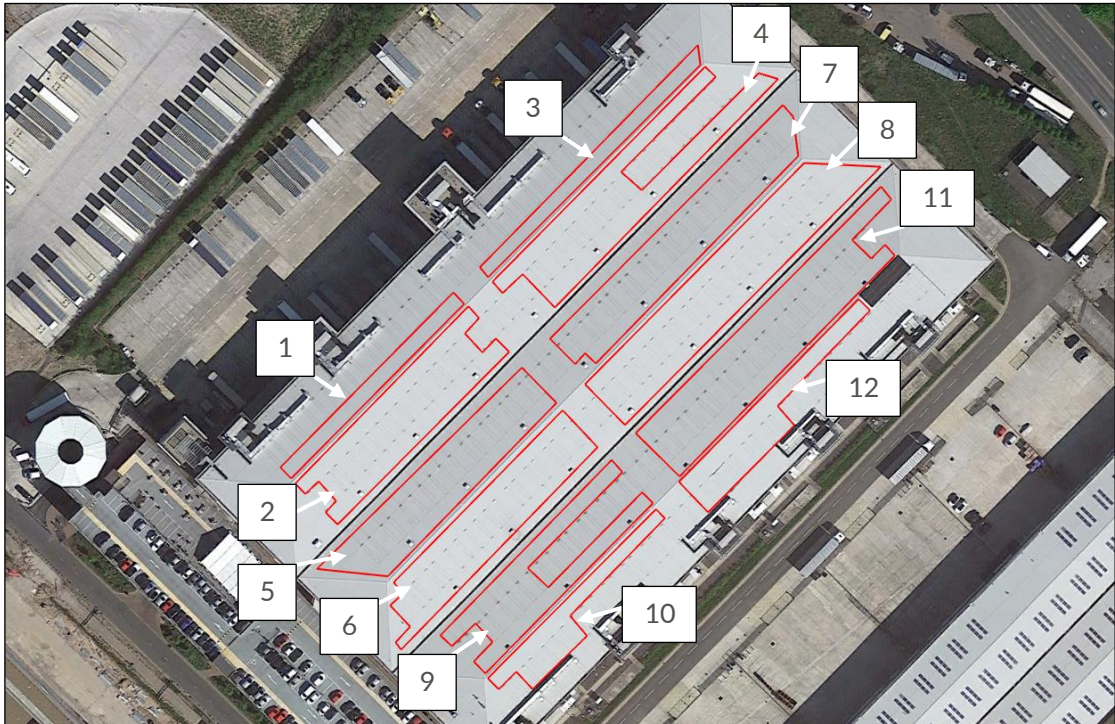


Figure 5 Solar panel areas – aerial image

The proposed rooftop solar panel development will be mounted directly to the roof and positioned based on the roof orientation and pitch. The mounting arrangement is shown in Figure 6⁸ below.

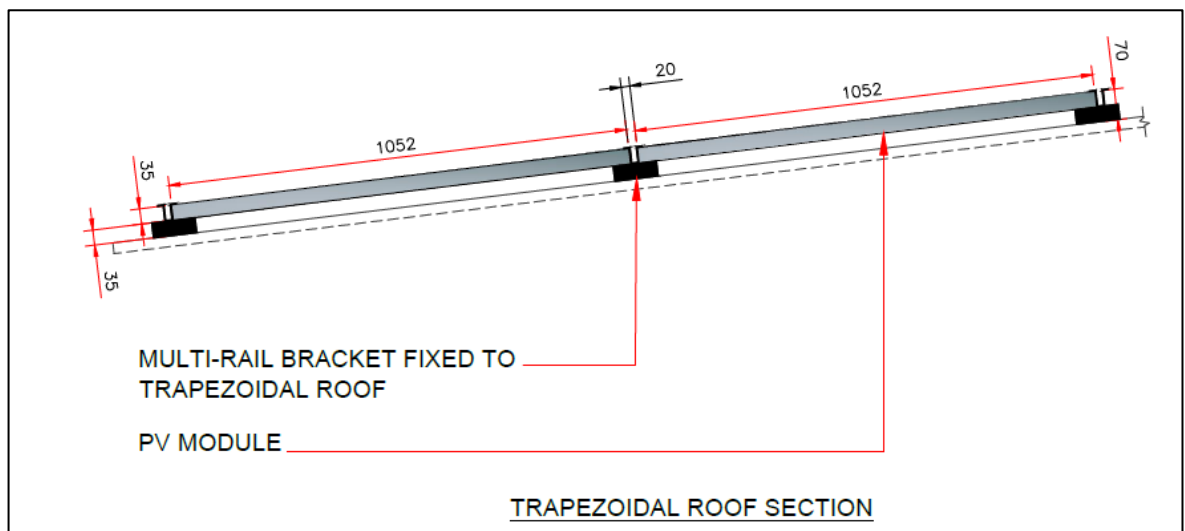


Figure 6 Solar panel mounting arrangement

⁷ Source: Copyright © 2021 Google.

⁸ Source: MAN1_M50_DET_Mounting System Details_C1.

The characteristics of the solar panels in the associated areas are presented in Table 1 below.

Areas	Height agl ⁹	Tilt	Orientation
1, 3, 5, 7, 9, 11	Approximate height of roof between 16.27m and 18.24m	6 degrees	315 degrees
2, 4, 6, 8, 10, 12			135 degrees

Table 1 *Panel area characteristics*

⁹ Above ground level

3 MANCHESTER AIRPORT DETAILS

3.1 Airport Information

Manchester Airport is a Civil Aviation Authority (CAA) licensed aerodrome.

Manchester Airport has two operational runways. The runway details are presented below:

- 05L/23R measuring 3,048m by 45m (concrete and asphalt);
- 05R/23L measuring 3,050m by 45m (concrete and asphalt).

The runways are shown on the aerodrome chart in Figure 10¹⁰ on page 21. The ATC tower location is circled (red circled yellow area) for reference.

An aerial image showing the proposed development location relative to Manchester Airport is presented in Figure 7¹¹ below.

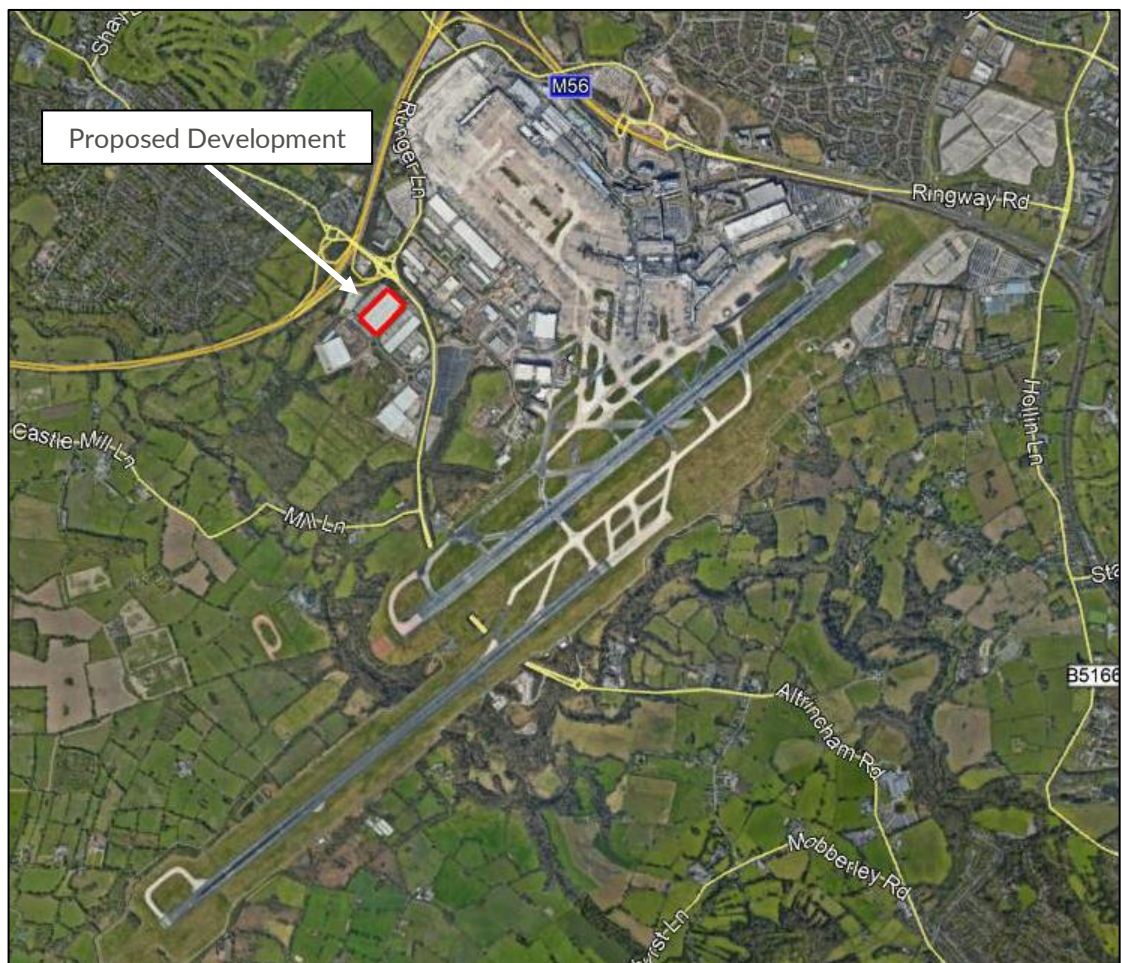


Figure 7 Proposed development location relative to Manchester Airport

¹⁰ Source: NATS AIP EG AD 2 EGCC 2-1 12/09/2019, accessed September 2019.

¹¹ Source: Copyright © 2021 Google.

3.2 Navigation Aid Details

Manchester Airport has numerous navigation aids to assist pilots. The types and details of the infrastructure present are presented in Table 2¹² below.

Type	Location	Antenna Altitude	Comment
Instrument Landing System Localisers	Located at numerous locations next to/in line with the runways focused on the bearing of the extended runway centre line.	Not stated	No significant safeguarding considerations due to the location of the proposed development with respect to the navigation aids.
Instrument Landing System Glide Paths			
Distance Measuring Equipment (DME)	Three individual DMEs: 1) -2.305761° 53.332939° 2) -2.273061° 53.353164°	1) 200ft Ground height = 53.25m 2) 263ft Ground height = 73.46m	Line of sight analysis and consideration of Building Restricted Areas completed for these navigation aids
DME/VOR (VHF omnidirectional range)	One co-located VOR/DME: 3) -2.262289° 53.357025°	3) 282ft Ground height = 77.91m	

Table 2 Navigation aid details

The location of the identified navigation aids relative to the existing commercial unit and proposed rooftop solar development is shown in Figure 8¹³ on the following page.

¹² Sourced from the NATS AIP.

¹³ Source: Copyright © 2021 Google.



Figure 8 Location of navigation aids relative to the existing commercial unit and proposed rooftop solar development

3.3 Radar Details

There are two radar situated upon the metal lattice tower. The lower radar is a non-cooperative PSR, the taller is the co-operative SSR which has been assessed within this report.

SSR broadcast interrogating radio signals that are detected by aircraft with on-board transponders. The transponder responds by broadcasting a radio reply which normally contains identification and altitude information. The SSR determines the aircraft's horizontal position from the direction the antenna is orientated and the time taken to receive a response from the interrogation.

Both radar will be used by air traffic controllers to provide approach services to aircraft landing at and departing Manchester Airport. Both radar will also be used by air traffic controllers at national air traffic control centres to provide services to en-route aircraft.

The radar most likely to be of significance is the SSR however both have been considered for completeness.

Table 3 below provides the details for the assessed radar. All height data has been provided by NATS.

Radar	Co-located Primary and Secondary Surveillance Radar (PSR and SSR)
Height of ground at the radar above mean sea level (amsl)	67m
Height of radar agl	28m (PSR) / 30m (SSR)
Overall radar height above mean sea level	95m (PSR) / 97m (SSR)
Average distance between the proposed development and radar	2.25km
Average grid bearing from radar to proposed development	340.5°

Table 3 Manchester radar location and height details

The location of the Manchester PSR and SSR is shown in Figure 9¹⁴ below.



Figure 9 Manchester PSR and SSR location

¹⁴ Source: Aerial imagery copyright © 2021 Google.

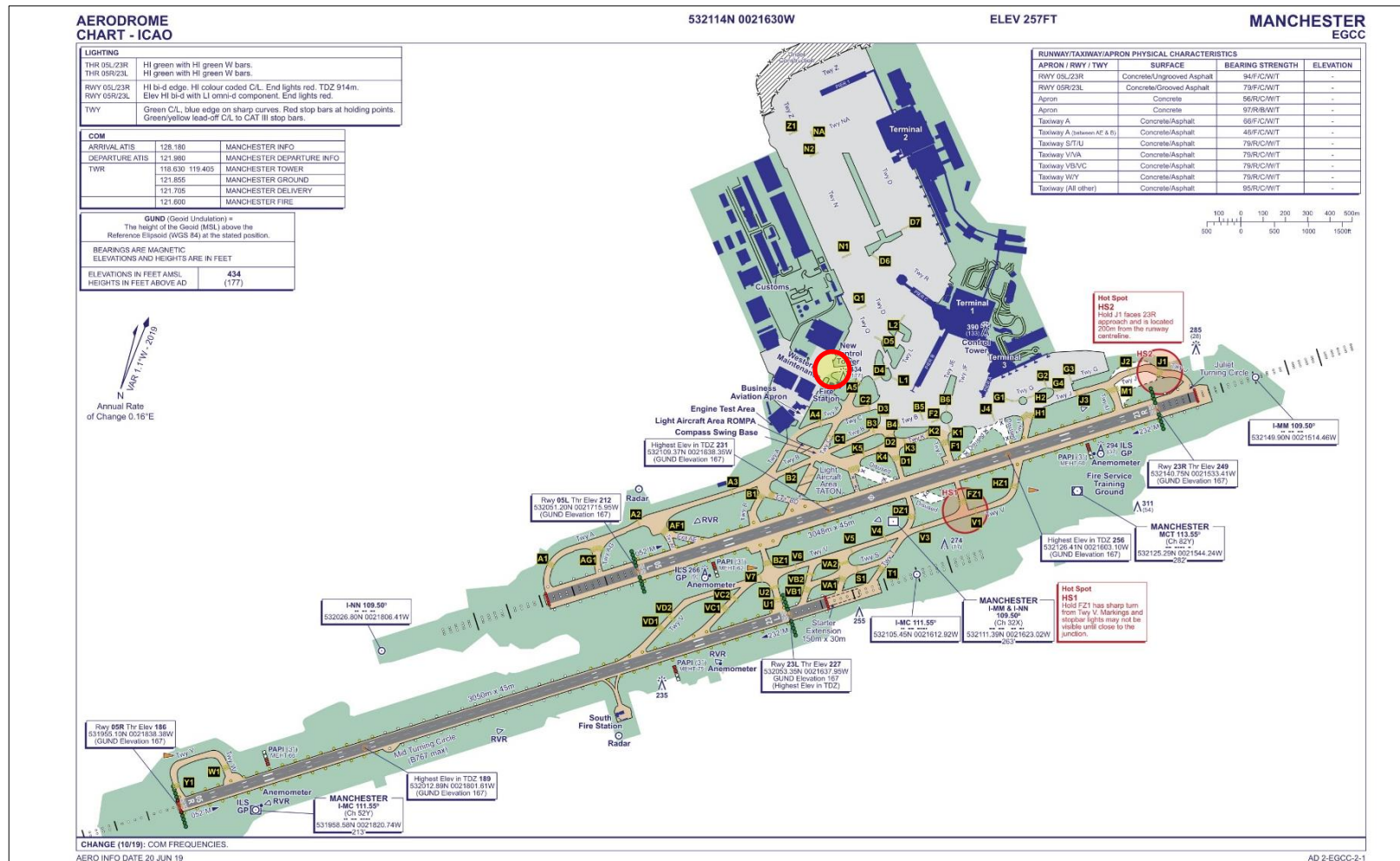


Figure 10 Aerodrome chart of Manchester Airport

4 GUIDANCE OVERVIEW

4.1 Overview

The following section presents the guidance associated with safeguarding of a or a DME and VOR, located singularly and co-located.

4.2 Guidance

Constraints have been identified and assessed with reference to the guidance presented below. The list of guidance documents reviewed are as follows:

- CAP 670 – Air Traffic Services Safety Requirements¹⁵;
- ICAO EUR DOC 015 – European Guidance Material on Managing Building Restricted Area¹⁶.

The relevant guidance for each of these documents is presented in the following sub-sections.

4.3 Navigation Aids

The following section presents the associated safeguarding guidance for the identified relevant navigation aids.

4.3.1 CAP Guidance

CAP 670 details the safeguarding criteria for the VOR/DME. The following text is taken from GEN02.18 to GEN02.19:

VOR

GEN02.18 At ground level a circle of 230 m radius from the site centre with a further slope at 2% (1:50) out to 900 m radially from the site centre.

DME

GEN02.19 The foregoing VOR constraints where co-located with a VOR otherwise a 2% (1:50) slope surface originating at the site ground level extending 300 m radially.'

Where a DME is co-located with a VOR, the more stringent VOR safeguarding criteria applies.

¹⁵ Third Issue, Amendment 1/2019, 1 June 2019, Effective 1 August 2019.

¹⁶ EUROPEAN GUIDANCE MATERIAL ON MANAGING BUILDING RESTRICTED AREAS - Third Edition - 2015. PREPARED BY THE EUROPEAN AND NORTH ATLANTIC OFFICE OF ICAO NOVEMBER 2015

4.3.2 ICAO Guidance

EUR DOC 015 details specific parameters for safeguarding VOR and DME located singularly and co-located. The document also describes the safeguarding area. This is described in the extract below.

'3.2 Building Restricted Area (BRA)

3.2.1 In the context of AWO¹⁷, the BRA is defined as a volume where buildings have the potential to cause unacceptable interference to the signal-in-space in the service volume of CNS facilities for AWO. All CNS¹⁸ facilities have BRA defined which are not limited to actual site boundaries of the facility but extend to significant distances from the facility.'

The text presented below describes the BRA:

'6. BRA for omni-directional facilities

6.1 The cylinder is referenced to the ground terrain; the cone is referenced to a horizontal plane. Where irregular terrain is present the BRA shape is adapted.

6.2 The BRA is considered to provide worst case protection.'

Figure 11 on the following page is taken from the document; it shows the general shape of the BRA associated with omni-directional facilities.

¹⁷ All Weather Operations

¹⁸ Communication, Navigation and Surveillance

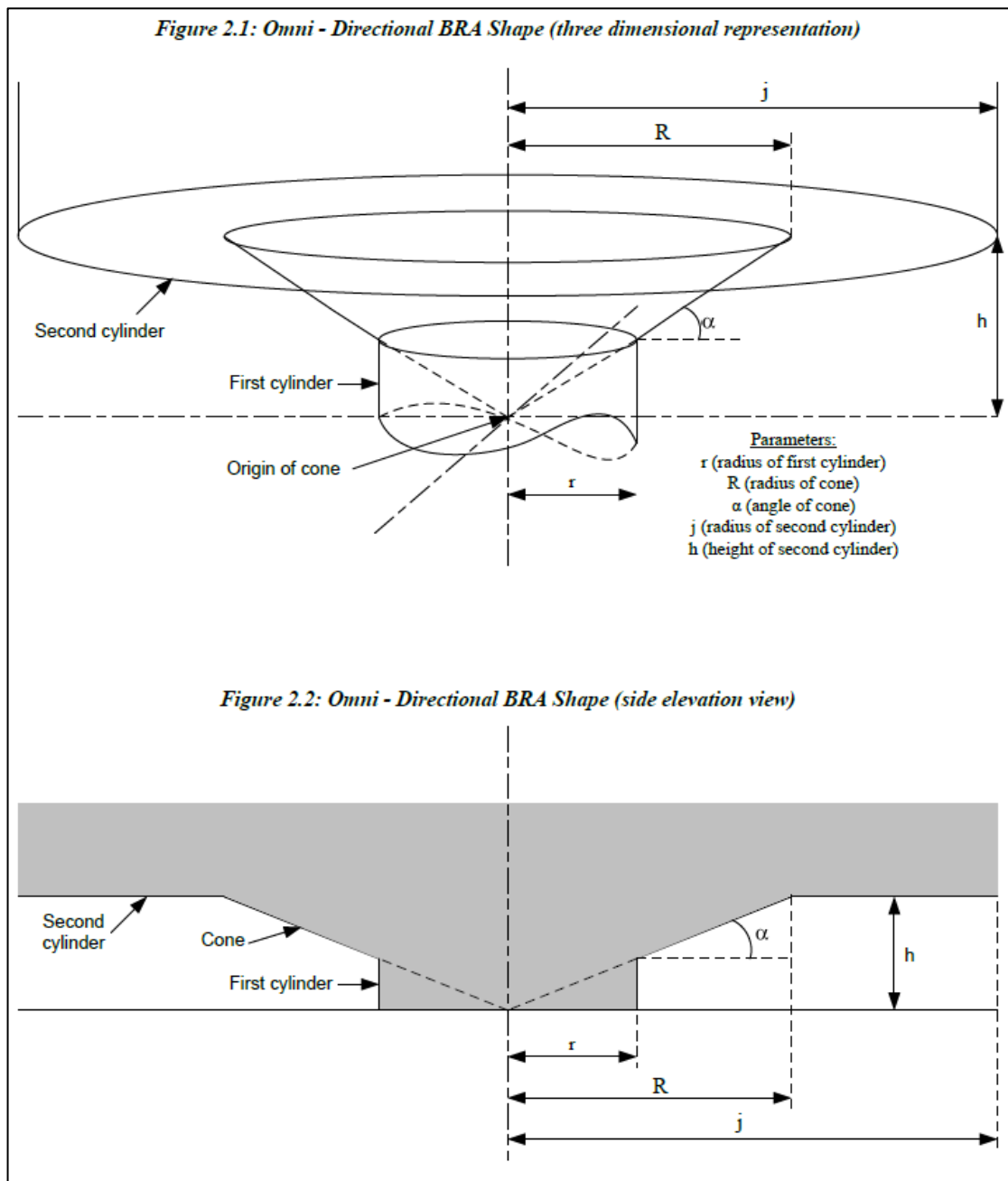


Figure 11 BRA diagram - ICAO

The following is general text from the document concerning a collocated DVOR/DME and the safeguarding of each, both individually and co-located:

'General notes for omni-directional and directional facilities

8.1 Where facilities are co-located the most stringent BRA volume applicable should apply.

...

8.4 Annex 14 surfaces are applicable and should also be taken into account.

8.5 The shapes are applicable from ground terrain upwards.

8.6 Local terrain and environmental constraints (e.g. humped runways) may modify the application of the shapes.'

Figure 12 below show the associated parameters for the VOR/DME BRA.

APPENDIX 1 – Navigational facilities						
Table 1: Harmonised guidance figures for the omni-directional navigational facilities in accordance with Figures 2.1 and 2.2						
Type of navigation facilities	Radius (r – Cylinder) (m)	Alpha (α – cone) (°)	Radius (R- Cone) (m)	Radius (j – Cylinder) (m) Wind turbine(s) only	Height of cylinder j (h -height) (m) Wind turbine(s) only	Origin of cone and axis of cylinders
DME N	300	1.0	3000	N/A	N/A	Base of antenna at ground level
CVOR	600	1.0	3000	15000	52	Centre of antenna system at ground level
DVOR	600	1.0	3000	10000	52	Centre of antenna system at ground level

Figure 12 VOR/DME BRA parameters

4.4 Radar

The following section presents the associated safeguarding guidance for the identified radar.

4.4.1 CAP Guidance

CAP 670¹⁹ presents no specific safeguarding criteria for radar, however details on the general process for safeguarding a PSR and SSR are given. The relevant section is presented below:

"Radar: 10 cm, 23 cm, 50 cm and SSR

GEN02.20 The radar system shall be safeguarded with criteria which are derived from the following as a minimum:

1. Operational Range.
2. Base of Coverage.
3. Operational Usage.

¹⁹ CAP 670, Air Traffic Services Safety Requirements. Issue 3 Amendment 1/2019. Effective 1 August 2019.

4. *Equipment Manufacturer's recommended clearances to prevent deterioration of the system's performance.*

GEN02.21 *The criteria for safeguarding should include the following for all radar systems:*

1. *A Sterile Zone around the antenna to permit clean, un-interrupted beam formation:*
 - a) *Which should be precisely defined with respect to a clear reference point on the antenna system;*
 - b) *Which should be derived from the vertical and horizontal beam patterns of the antenna type;*
 - c) *Which should state both the vertical and horizontal extents of the Sterile Zone.*
2. *A safeguarded slope should be defined around the system which shall assure the system's performance such that it continues to support the operational requirement:*
 - a) *Which should be precisely defined with respect to a clear reference point on the antenna system;*
 - b) *Which should define the gradient of the slope.*
3. *The criteria should also include consideration of the construction, shape, location, orientation and materials used in any application.*

Note 1: Example of Sterile Zone criteria: 'The Sterile Zone is an area of z metres in radius centred on the rotation axis of the radar antenna. The zone extends y metres below the electrical centre of the antenna.'

Note 2: Example of slope criteria: 'The protected slope shall be 1 in a, centred on a point on the rotation axis of the radar antenna that is b* metres below the lower edge of the antenna. The slope shall extend to a ground distance of c* metres from the rotation axis of the antenna.' *a, b and c are numbers defined by the system characteristics.*

GEN02.22 *For clarity, the safeguarded areas should be described diagrammatically as well as textually."*

The CAP guidance specifically mentions the sterile zone however no exclusion zone distance is provided.

4.4.2 ICAO Guidance

It is recommended within ICAO DOC 015 that assessment of all structures surrounding a PSR and SSR should be modelled against Building Restricted Area (BRA) associated with the safeguarding of the radar:

"It is recommended that buildings such as skyscrapers, large excavating works, TV towers and other high towers should be assessed at all times even outside the BRA for omni-directional/directional facilities. Particular attention should be paid to clusters of buildings and overhead power lines."

Furthermore, other instrumentation used for the construction of the proposed building should be considered for the assessment:

"The development of the guidance material has been with the notion of building in mind. However the guidelines developed apply equally well for other objects whether moving or stationary, temporary or permanent causing interference to the radio signals of CNS facilities, such as machines, constructions used for the erection of buildings as well as excavation and spoil or even vegetation."

The document provides the rules which define the BRA Shape. The BRA shape required for an omni-directional facility such as a PSR and SSR is shown in Table 4 below.

The omni-directional BRA is composed of two cylinders and a cone. The cylinder is referenced to the ground terrain at the base of the radar out to 500m. The cone is also referenced to the ground terrain at the base of the radar and extends at an angle of 0.25° outwards to a distance of 15km. Where irregular terrain is present, the BRA shape is adapted.

The dimensions of the BRA shape are presented in Table 4 below.

Type of navigation facilities	Radius (r – Cylinder) (m)	Alpha (a-cone) (°)	Radius (R-Cone) (m)	Origin of cone and axis of cylinders
PSR	500	0.25	15000	Base of antenna at ground level
SSR				

Table 4 Harmonised guidance figures for the omni-directional surveillance facilities

The shape for the omni-directional BRA for a PSR and SSR is as per Figure 11 on page 23.

4.5 Summary

CAP guidance safeguards the individual DME out to 300m whereas ICAO suggests safeguarding the DME out to 3000m.

Where the DME is co-located, the VOR criteria applies. CAP guidance safeguards the VOR out to 900m radially from the VOR. ICAO guidance safeguards out to 3000m and is the most restrictive for both the VOR and DME. In most instances, CAP guidance is applicable in the UK, however ICAO criteria has been known to be used.

Only the ICAO guidance provides specific figures for the safeguarding of PSR and SSR. The BRA in all instances is however not an exclusion zone, but an indicator to determine the requirement for further detailed analysis.

High-level analysis is presented in the following section.

5 CONSIDERATION OF SAEGUARDING CRITERIA

5.1 Overview

The following section presents the results of the ICAO BRA calculations and comments regarding the CAP 670 methodology.

5.2 ICAO DME/VOR BRA Results

The results of the BRA calculation for the DME and VOR are presented in Table 5 below.

Aviation Infrastructure	Key Details	Infringement/Clearance
DME 1	Ground height at DME = 53.25m AOD Distance to nearest corner point = 2,920m Maximum elevation of building/solar panels = 83.15m AOD	Commercial unit (existing) and rooftop solar panels (proposed) are clear of BRA by 21.1m.
DME 2	Ground height at DME = 73.46m AOD Distance to nearest corner point = 1,476,	Commercial unit (existing) and rooftop solar panels (proposed) are clear of BRA by 16.1m.
VOR/DME 3	Ground height at VOR/DME = 77.91m AOD Distance to nearest corner point = 2,016m	Commercial unit (existing) and rooftop solar panels (proposed) are clear of BRA by 29.9m.

Table 5 BRA calculation result – DME and VOR

The commercial unit and proposed rooftop solar development do not infringe the BRA associated with DME/VORs. No safeguarding issues would be anticipated.

5.3 ICAO PSR and SSR BRA Results

The results of the BRA calculation for the PSR and SSR are presented in Table 6 below.

Aviation Infrastructure	Key Details	Infringement
Manchester PSR/SSR	Ground height at radar = 64.5m AOD Distance to nearest corner point = 2.146km Maximum elevation of building/solar panels = 83.15m AOD	Commercial unit (existing) and rooftop solar panels (proposed) infringe the BRA by 9.3m.

Table 6 BRA calculation result – PSR and SSR

5.4 Consideration of CAP 670 Clearance Criteria

All navigation aids are sufficiently beyond the safeguarding distances presented within CAP 670 from the proposed development (300m for DME and 900m for VOR). No safeguarding issues would be anticipated using CAP 670 criteria.

5.5 Safeguarding Criteria Conclusions

The commercial unit and proposed rooftop solar development do not infringe the safeguarded surfaces based on ICAO and CAP guidance for DME/VORs.

A maximum infringement of 9.3m is predicted based on ICAO guidance for the PSR and SSR. CAP guidance does not provide specific safeguarding criteria.

6 LINE OF SIGHT ANALYSIS

6.1 Overview

Line of sight analysis has been completed to determine the extent of the visibility to key aviation infrastructure at Manchester Airport.

6.2 Technical Assessment

The line of sight analysis includes the following steps:

- Line of sight assessment to each tower within the proposed development;
- Review of screening to determine whether existing buildings and/or landscape features would hide/shield the proposed development from the PSR;
- Analysis conclusions.

6.3 Line of Sight Analysis

A radar line of sight assessment was completed for the four perimeter co-ordinates of the building on which the solar panels will be located. The co-ordinate and height data of these points is presented in Appendix A.

Figures 13-17 on the following pages show the line of sight chart from the key aviation infrastructure (VOR/DME, PSR and SSR) for the closest, most visible corner point (based on bare earth terrain). Information regarding the methodology or the additional line of sight charts can be provided upon request.

The box labelled 'certainty' in both figures provides the distance (in metres) by which the building is or is not within line of sight to the assessed radar (rounded to one decimal place).

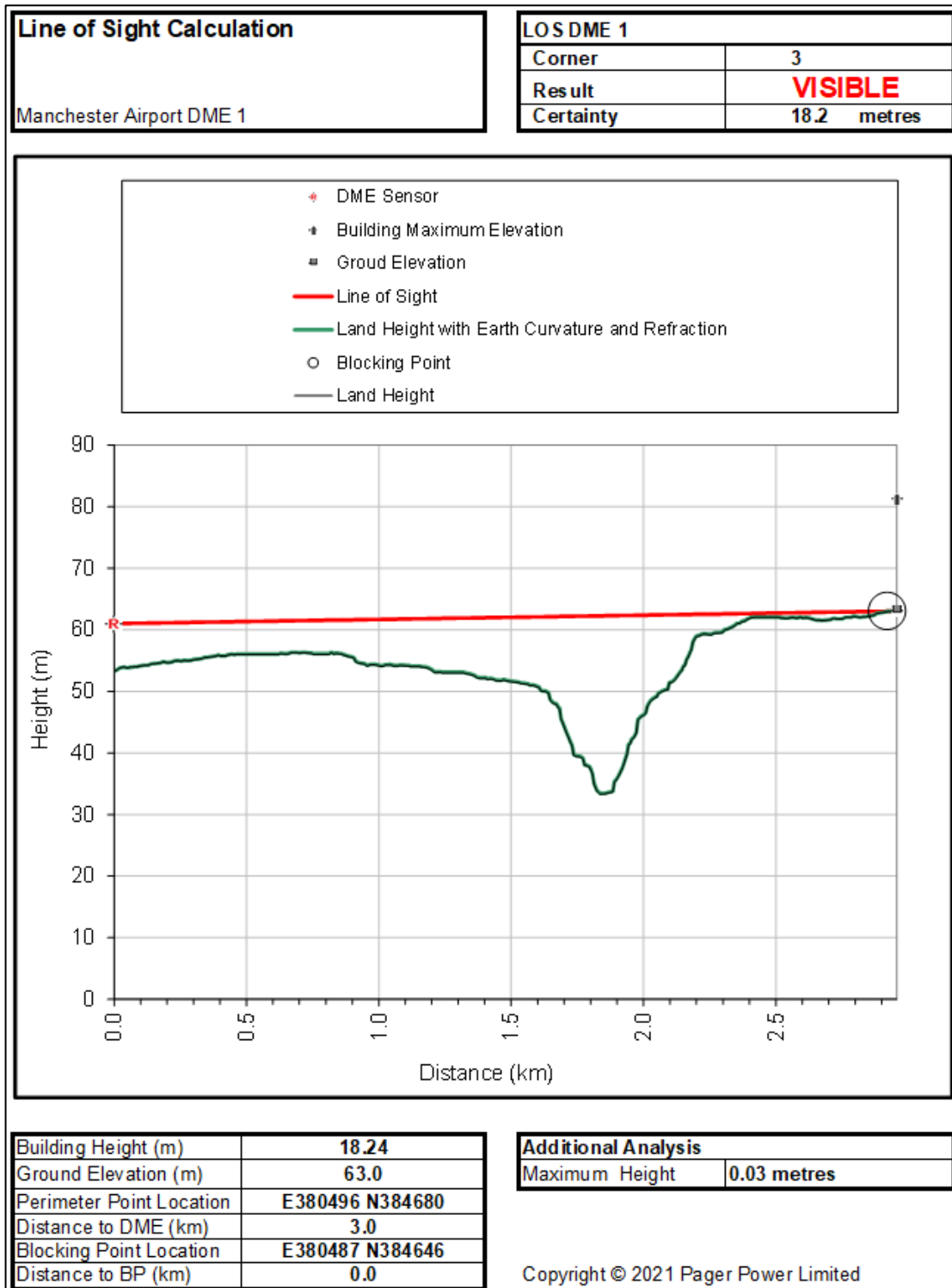


Figure 13 Radar line of sight chart to corner 3 from DME 1

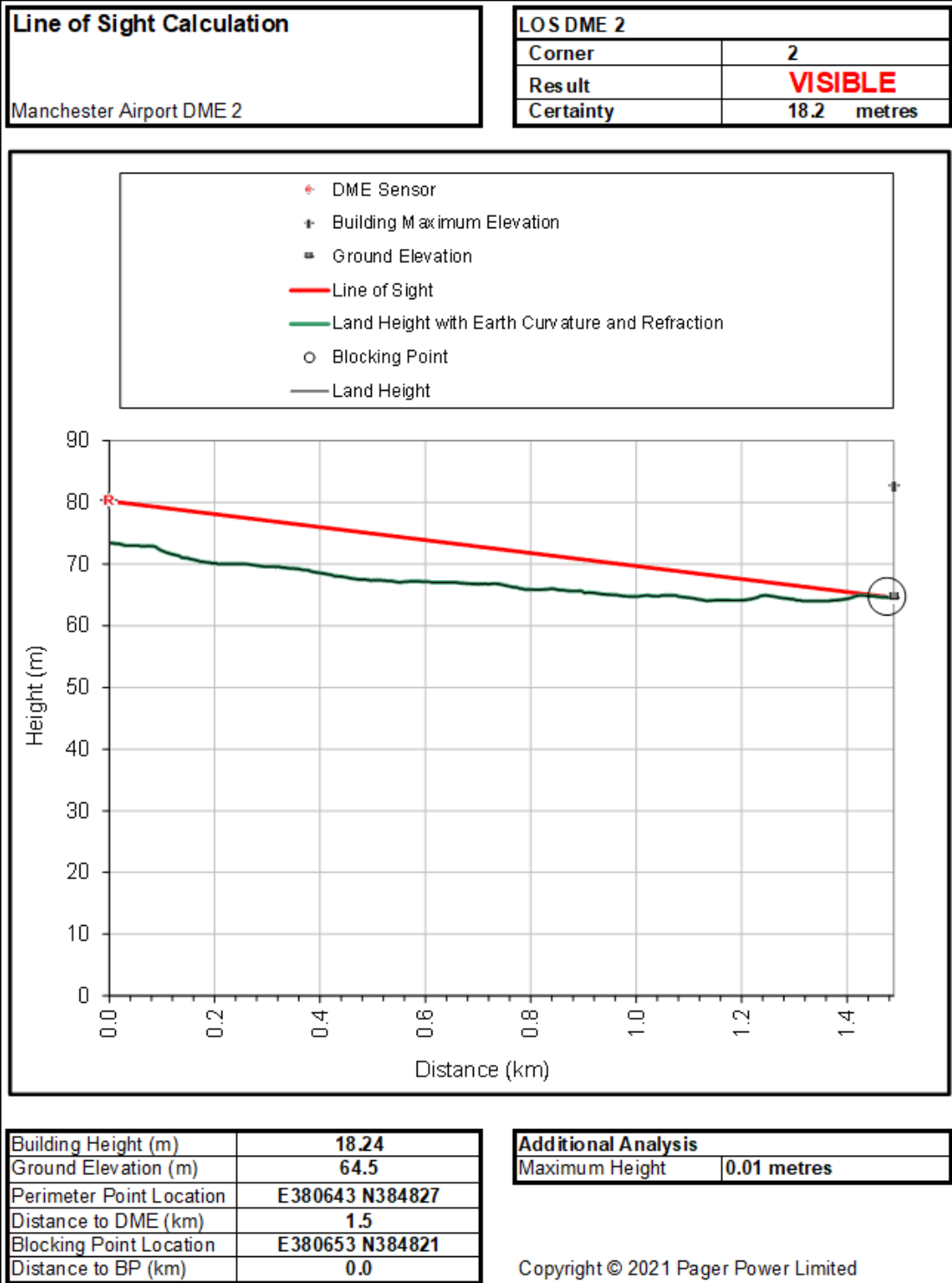


Figure 14 Radar line of sight chart to corner 2 from DME 2

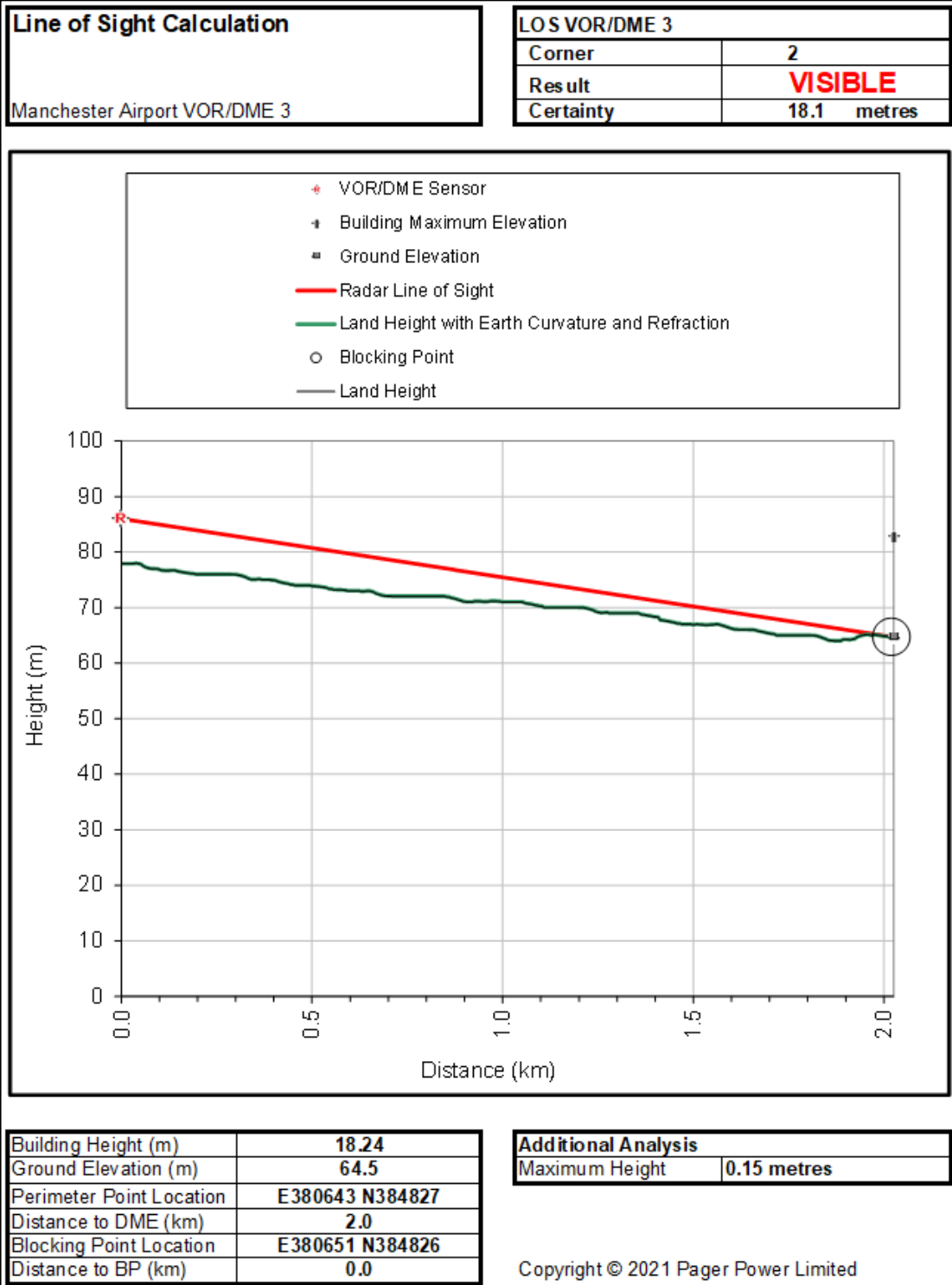


Figure 15 Radar line of sight chart to corner 2 from VOR/DME 3

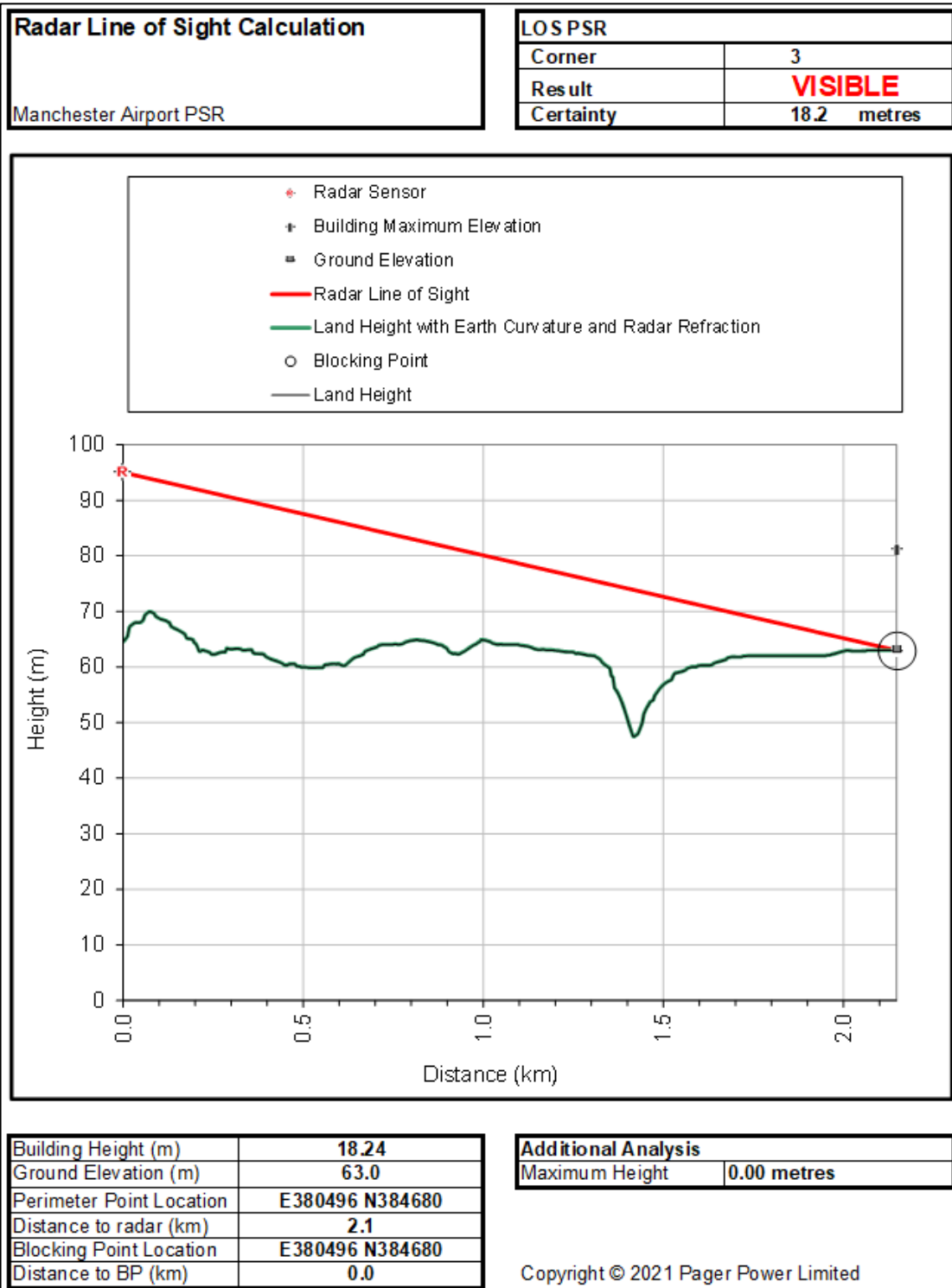


Figure 16 Radar line of sight chart to corner 3 from the PSR

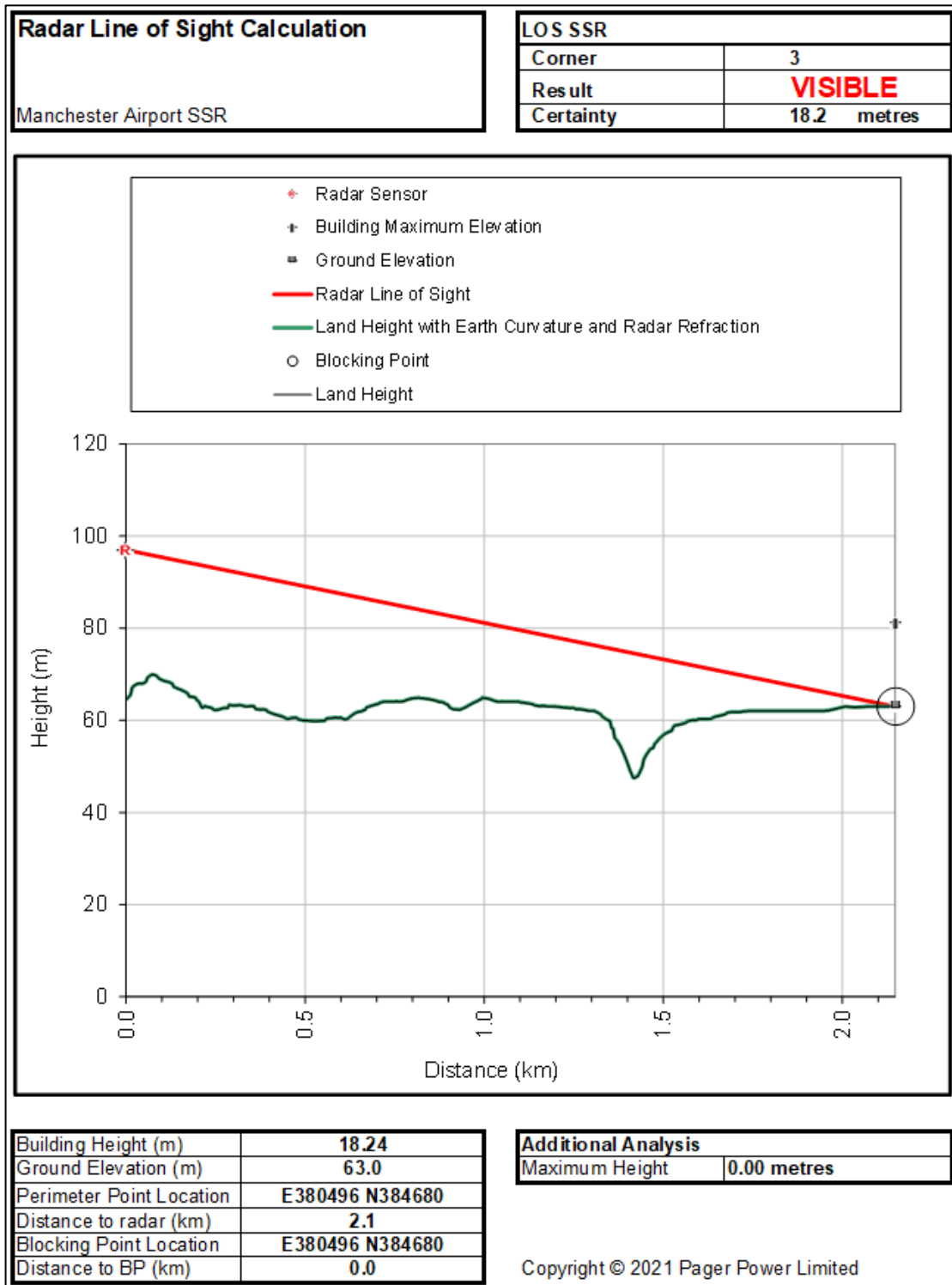


Figure 17 Radar line of sight chart to corner 3 from the SSR

6.4 Additional Screening

The modelling described in the sections above accounts for the intervening bare earth terrain only. It does not account for additional obstructions on the ground along the line of sight e.g. buildings or vegetation.

Inspection of the aerial imagery suggests that existing obstructions are likely to provide some level of screening by aviation infrastructure (buildings) present on the airport. The identified screening has been plotted²⁰ on the updated line of sight profiles, where applicable. Figures 18 and 19 below and on the following page present the updated line of sight profile for DME 2 and VOR/DME 3.

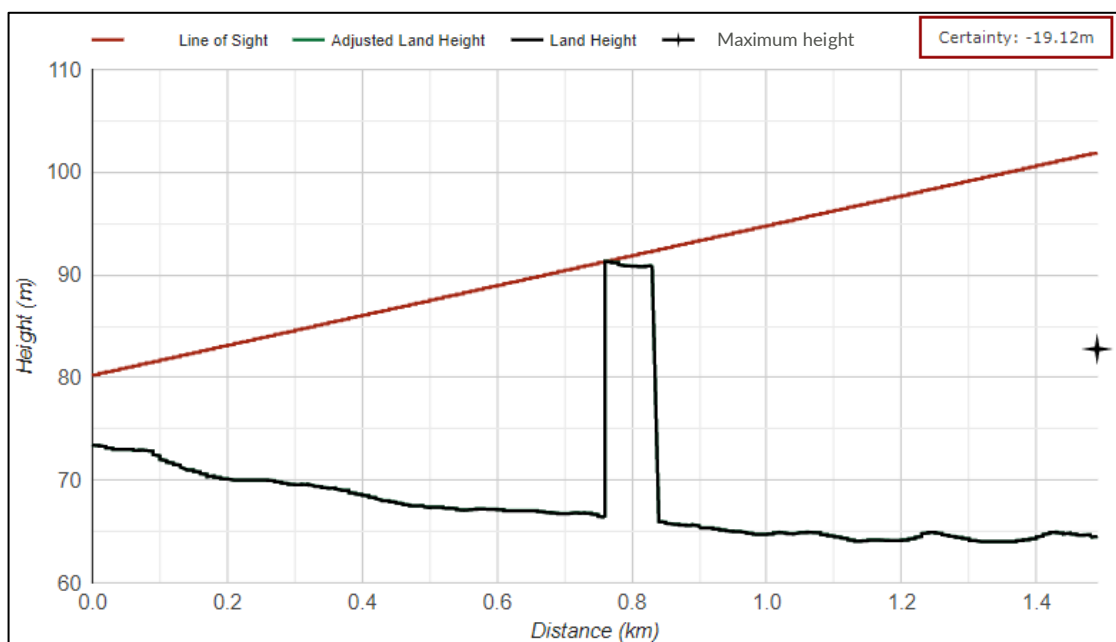


Figure 18 Screening for corner 2 - DME 2

There are large areas of significant screening with respect to the building as a whole, however the proposed rooftop solar panels may still be partially visible. The main obstructions include the blast fence, Signature Flight Support Hangar and the Jet2 Hangar. The effect of the Jet2 Hangar on the visibility of the closest corner (Corner 2) is shown in Figure 18 above.

²⁰ Only the most significant structure has been plotted.

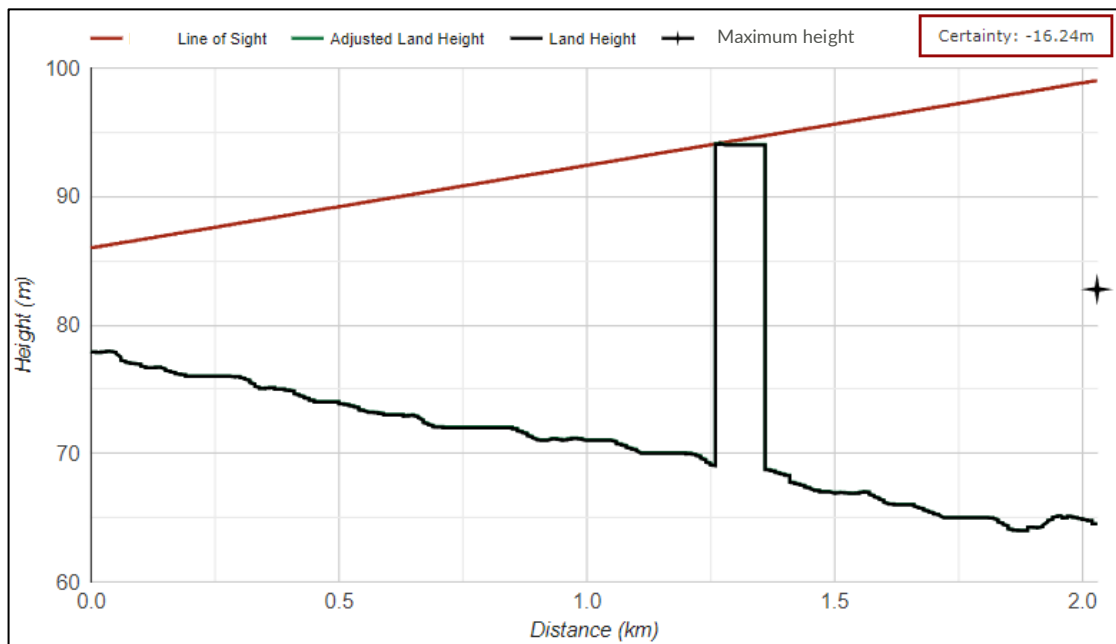


Figure 19 Screening for corner 2 - VOR/DME 3

Like for DME 2, there are large areas of significant screening with respect to the building as a whole, however the proposed rooftop solar panels may still be partially visible. The main obstructions include the Thomas Cook Hangar and what appears to be a bus depot. The effect of the Thomas Cook Hangar on the visibility of the closest corner (Corner 2) is shown in Figure 19 above.

For the remaining navigation aid (DME 1) and radar (PSR and SSR), visibility of the rooftop solar panels is anticipated, with no obstructions expected to reduce visibility of the solar panels.

6.5 Radar Line of Sight Conclusions

All five navigation aids and radar assessed are expected to at least have partial visibility to a section of the rooftop solar panels (only those panels on a bearing of 135 degrees due to the orientation of the building relative to the navigations aids and radar). However, all navigation aids and radar already operate in a complex environment with many static structures present in close proximity. Indeed, the rooftop on which the solar panels are mounted is already present. The solar panels will be mounted at the same inclination as the current roofline, as close to the existing roof as possible and not extend its overall height. Therefore, considering these basic principles, it is deemed very unlikely that the presence of the rooftop solar panels would have any significant impact over the existing baseline conditions.

7 OBSTACLE LIMITATION SURFACES ASSESSMENT

7.1 Overview

The Obstacle Limitation Surfaces (OLS) for Manchester Airport have been modelled with respect to the building perimeter coordinates modelled at the maximum elevation of the existing commercial unit. The aim is to identify whether the proposed development would infringe the OLS at Manchester Airport.

7.2 Manchester Airport Obstacle Limitation Surfaces

Obstacle Limitation Surfaces are imaginary planes defined in three dimensions for physical safeguarding purposes (i.e. ensuring that physical structures do not present a safety hazard at an airfield) and are defined around licensed airfields. The dimensions and geometry of the surfaces are constructed based on detailed rules defined in the UK Civil Aviation Authority's Civil Aviation Publication 168. The size of the surfaces is dependent on the number of runways, their dimensions and the procedures carried out at the airfield.

It is understood that the solar panels will not increase the maximum elevation of the building due to the pitched roof. Table 5 below presents a summary of the OLS assessment results.

Building Plot	Height above mean sea level (amsl) (m) ²¹	Relevant Surface	Vertical Clearance ^{22,23} (m)
1	83.15	Inner Horizontal Surface (OHS)	18.54
2			
3			
4			

Table 7 OLS detailed results

7.3 Conclusion

The proposed rooftop solar panels are well clear of the IHS and pose no physical safeguarding risk.

²¹ Ground height taken from the worst-case (highest) terrain point at the four modelled corner points based on OSGB36 terrain data.

²² Vertical clearance between the corner point and the Inner Horizontal Surface.

²³ These calculations have been based on an Inner Horizontal Surface of 101.6928m Above Ordnance Datum (AOD).

8 OVERALL CONCLUSIONS

8.1 Conclusions

The proposed development will consist of low-lying rooftop solar panels mounted to the angled roof (6 degrees) of an already constructed large commercial unit. There are no known safeguarding issues surrounding the existing commercial unit²⁴.

The relevant navigation aids (DME and VOR) have been assessed with respect to the associated ICAO BRA and CAP safeguarding criteria. No infringement of the surfaces associated with ICAO or CAP safeguarding criteria has been calculated. No significant impact upon the DMEs or VOR is therefore predicted.

The proposed solar development will be in line of sight to the PSR and SSR, both of which are located to the south of the airport. The solar panels will cover a rooftop which is visible to both radar. The proposed development will also lie below the horizontal relative to the radar. On the basis of no pre-existing issues surrounding this rooftop causing reflections or shadowing effects, the proposed development will likely produce a negligible change over the baseline conditions.

The proposed development will not increase the height of the building however, for completeness, an OLS assessment was completed. The analysis showed that the solar panels (and the building) would have a minimum clearance of 18.5m from the IHS. Therefore no physical safeguarding issues exist.

8.2 Overall Conclusion and Recommendations

The proposed rooftop solar development will produce a negligible change to the baseline condition already present due to the presence of the commercial unit.

This report should be shared with the safeguarding team at Manchester Airport.

²⁴ To the authors knowledge and as indicated through the analysis in this report.

APPENDIX A – ASSESSED CO-ORDINATES

Assessed Co-Ordinates

The assessed perimeter co-ordinates of the existing commercial unit are presented in the table below.

ID	Easting	Northing	ID	Easting	Northing
1	380557.4	384913.1	3	380496.8	384681.6
2	380643.4	384828.7	4	380411.6	384766

Assessed perimeter co-ordinates of the existing commercial unit



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