TECHNICAL ASSESSMENT (MAIN REPORT)

Of the Possible Impact of the IFA2 Interconnector on the Solent Airport, Daedalus

35588100/NT/300916/1

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Incorporating

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0	DRAFT	09/09/2016	Draft Report issued for comment.		
1	1	30/09/2016	First Issue	To address comments raised on the Draft Issue	
1	2	10/10/16	Issue 1 Rev 2	To address comments on Revision 1	

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43	CAA, AOA Advice Note 2	Safeguarding of Aerodromes: Advice Note 2 – Lighting near Aerodromes
44	BS 5489	Code of Practice for the design of road lighting, Part 1 Lighting of roads and public amenity areas (BS 5489-1:2003) section 12.2 Lighting in the vicinity of aerodromes
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49	Directive 2013/35/EU	EU Directive on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC
50	CIGRE 391	Guide for measurement of radio frequency interference from HV and MV substations.
51	IEC 61000	A series of standards relating to Electromagnetic Compatibility.
52	OVE-IFA2-REP-001	National Grid IFA2 Converter - TV and Radio Reception Study
53	SAEM/2015/019/TR/002	Aircraft Magnetic Field Susceptibility Assessment Report for IFA2

TERMS AND DEFINITIONS

Term / Abbreviation	Definition
Airport	Solent Airport at Daedalus
AC	Alternating Current
AGL	Aeronautical Ground Light
AIP	Aerodrome Information Package
ALARP	As Low as Reasonably Practicable
AOA	Airport Operators Association
ARP	Aerodrome Reference Point
ATS	Air Traffic System / Air Traffic Services
BHMP	Bird Hazard Management Plan
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CEMAST	Centre of Excellence in Engineering and Manufacturing Advanced Skills Training
CFD	Computational Fluid Dynamics
CIGRE	Conseil International des Grands Réseaux Électriques
DC	Direct Current
DfT	Department for Transport
EMC	Electromagnetic Compatibility
EMF	Electromotive force
EPSRC	Engineering and Physical Sciences Research Council
FBC	Fareham Borough Council
FHA	Functional Hazard Assessment
GB	Great Britain
HIRA	Hazard Identification and Risk Assessment

Term / Abbreviation	Definition
HMS	Her Majesty's Ship
HV	High Voltage
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IFA2	The IFA 2 Interconnector, being developed by National Grid jointly with Reseau de Transport d'Electricite
IHS	Inner Horizontal Surface
ILS	Instrument Landing Systems
kV	Kilovolt
MW	Mega Watt
National Grid	National Grid Interconnector Holdings
NG	National Grid Interconnector Holdings
NGET	National Grid Electricity Transmission
NOTAM	Notice to Airmen
OFZ	Obstacle Free Zone
OLS	Obstacle Limitation Surfaces
RCA	Regional and City Airports
RCAM	Regional and City Airports Management
RFI	Radio frequency interference
SMS	Safety Management System
Solent Airport	Solent Airport at Daedalus
The (Control) Tower	The Control Tower at Solent Airport
VFR	Visual Flight Rules

Term / Abbreviation	Definition
VSC	Voltage Source Converter

EXECUTIVE SUMMARY

Arcadis has been contracted to undertake an initial technical assessment of the proposed converter station to be sited adjacent to Solent Airport, Lee-on Solent. The assessment has been commissioned by National Grid Interconnector Holdings (National Grid) and is also intended for the benefit of stakeholders, in particular Fareham Borough Council as Landowner and Regional City Airports and Management (RCAM) as the Operator of Solent Airport, as well as other 3rd parties including the public.

The converter station is part of the IFA2 electricity interconnector facility being developed jointly with Reseau de Transport d'Electricite, the French transmission system owner and operator.

The scope of this technical assessment covers the potential impact of the converter station on the existing airport operations. The scope was agreed jointly between National Grid, Fareham Borough Council and RCAM. Any impact from future airport and non-airport developments within the area will be assessed separately; however, some issues that may need to be considered for future developments have been identified.

A technical assessment has been carried out which covers aerodrome safeguarding, assessment of electromagnetic field (EMF) / radio-frequency interference (RFI) and wind effects, together with hazard identification and risk assessment. This is to provide stakeholders with the necessary safety assurance at the planning and land acquisition stage, and to provide a firm basis for the eventual detailed design development and safety justification of the converter station. The specific tasks carried out to assess any potential safety impact upon existing airport operations from the proposed converter station are listed below:

- Task 1 – technical assessment of the Aerodrome Safeguarding in accordance with CAP 738.
- Task 2 – technical assessment of EMF and RFI and peer review of previous analysis undertaken.
- Task 3A – peer review of a previous wind effects analysis.
- Task 3B – a hazard identification and risk assessment study in the form of a functional hazard assessment (FHA) in accordance with CAP 760. This brings together the separate strands of work and assesses any increase in risk to the Airport and aircraft operations along with any other foreseeable hazards / risks.

From the information available at this time, it is concluded that the risks posed by IFA2 are not expected to adversely impact the Airport's current operations and any hazards are expected to be straightforward to manage. There are no issues identified that would prevent National Grid and Fareham Borough Council proceeding to the land acquisition stage. As is typical with any major project, attention will be required to the recommendations for the detailed design and the future operational environment; recommendations are captured in Section 9.4. These are expected to be dealt with as part of the future planning process and agreements and the design specifications for the facility.

Conclusions from each of the tasks are summarised below.

Aerodrome Safeguarding

Overall, the plans for the IFA2 converter station will not conflict with aerodrome safeguarding criteria. There are a few minor issues to consider when developing the final plans and detailed design, but the general principle of the development to date is considered to be acceptable and any safety risks are expected to be acceptable in accordance with CAP 760 [8].

A flat or low-pitched roof on the converter station could attract birds; however, the site is within the Airport boundary and will be well maintained and inspected with a bird hazard management plan in place.

Lighting at the converter station should follow the Airport Operators Association advice to ensure that the operation of the airfield is not adversely impacted at night. Currently night time flying is not permitted, however this is a possibility in the future.

The above actions are captured in the Hazard Log [48] for ongoing management.

Technical Assessment – EMF/RFI

The assessment of EMF and RFI effects is undertaken at the planning stage when the details of the design of the converter station are not finalised in design specifications. Hence, it is based on a number of assumptions, consistent with the preliminary assessment in [3] which are considered to be reasonable, but will need to be validated as the design progresses.

The assessment concludes that within the scope of this study (i.e. impact on existing airport operations) the risks from EMF and RFI effects is expected to be acceptable as defined by CAP 760 [8]. All actions relating to mitigation measures identified to ensure risks are acceptable are recorded in the Hazard Log [48] to be managed and tracked to closure over the project lifecycle.

Analysis undertaken so far has focussed on the existing airport operations and in particular the safety systems. Recommendations are given (Section 9.4) to develop the analysis as the design progresses in order to provide a robust safety and technical justification for EMF and RFI effects and confirm that risks are acceptable as defined in CAP 760 [8]. Additionally, the assessment has taken into consideration future plans for the Airport and the surrounding area where they are known, with recommendations raised for further assessment work in the future. National Grid are taking forward these recommendations for further assessment; recent detailed assessments have been completed or are in hand to consider in more detail the impact on digital television signals, aircraft equipment and specific stakeholder interests and they are considering implementing a practical communication interference test.

Wind Effects

The assessment of wind effects has peer reviewed the previous assessment in Reference [2] and undertaken some independent analysis to confirm that any impact of wind is small.

The preliminary analysis has been carried out for a bounding case, based on pessimistic assumptions in terms of distance from the runway, wind speed and wind angle. A wind speed of 20m/s has been assumed to allow for gusts of wind, with a distance of 200m perpendicular to the disused runway (the main runway being further away at 314m).

The analysis shows that instances of strong winds from the worst case direction is very low. The worst case effect predicted is an increase of 20% at ground level (1m) due to the geometrical shape of the development which indicates an increase in the levels of turbulence. If the simulation is to be conducted at lesser (more realistic) wind speeds, we would expect a similar increase ranging from 15% to 20%.

National Grid are planning additional wind analysis to examine the sensitivity to the parameters and considering wind effects around the main runway. This is raised as a recommendation in Section 9.4.

The impact of the localised wind effects on the aircraft has been considered as part of the FHA in Section 8. Risks are expected to be acceptable as defined in CAP 760 [8] for current airport operations with any localised impacts managed through airmanship and reports to airport management to be included in Notice to Airmen (NOTAMs) if necessary. It is considered however that this should be reviewed for future airport operations.

Hazard Identification and Risk Assessment

An FHA was undertaken, which considered all the foreseeable hazards due to the IFA2 converter station. Hazards were categorised in terms of severity with most being categorised as having "no immediate effect". The following hazards were pessimistically categorised as 'significant' in terms of severity as they have the potential to reduce safety margins, but with a number of barriers to prevent an accident occurring. It was also identified that these hazards need to be reviewed as the project lifecycle progresses:

- wind impact (e.g. turbulence). Wind effects due to the converter station are expected to be limited. Any change in the wind patterns can be managed for existing airport traffic by familiarisation, awareness and generally good airmanship, further assessment may be required to confirm this for future aircraft;
- bird strike, a flat or low-pitched roof could attract birds. A bird management strategy needs to be in place and consideration needs to be given to future landscaping and the choice of trees. The building design needs to provide access to the roof for bird management;
- distraction of aircrew caused by reflection from the building structure and cladding (glare). The buildings should be designed not to present a distraction to aircrew. The buildings should have non-reflective cladding. Fareham Borough Council should also consider placing conditions on the use of the land to require no services likely to cause reflections / glare distracting to aircraft.

Although it is too early in the design of IFA2 to reliably assign probabilities to hazards, the severities of all risks were such that their successful management should not be particularly onerous.

A number of actions are highlighted to manage as the planning process, design and further work progresses, to ensure that the risks are confirmed as being acceptable as defined in CAP 760 [8] and as low as reasonably practicable. The Hazard Log in [48] provides the basis for managing these to closure. The Hazard Log is a record keeping tool applied to tracking all hazard analysis, risk assessment and risk reduction activities for the complete life cycle of the project and is the key source in which the project's safety risk management activities are recorded. The Hazard Log should be used by National Grid and / or Fareham Borough Council to manage and track the hazards and risks through to closure over the duration of the project lifecycle. On completion of the project, any residual risks that require ongoing management through operational procedures and measures should be transferred to any hazard logs that Fareham Borough Council may have as Landowner and the Solent Airport hazard register.

1 INTRODUCTION

National Grid Interconnector Holdings (National Grid) is proposing to develop and implement an electricity interconnector facility. The facility (referred to as IFA2) is being developed jointly with Reseau de Transport d'Electricite (RTE), the French transmission system owner and operator. It links the United Kingdom's electricity transmission network with France's, and helps to enhance the security, affordability and sustainability of energy supply to both countries.

The facility consists of two converter stations, one sited in each country. It is to be sited to the north-east of Solent Airport, with high-voltage direct current (HVDC) and high-voltage alternating current (HVAC) cables proposed to be routed in the same cable corridor to the west and north of the main runway.

National Grid, in agreement with Fareham Borough Council and RCAM, has commissioned a number of initial assessments as part of best practice development and design to determine whether the siting of the converter station at Solent Airport could impact the Airport's operations. These assessments will also help to address local concerns over the proposals to site the converter station at Solent Airport and have already provided supporting information to the Public Consultation Process being led by Fareham Borough Council.

As part of this work, National Grid has commissioned Arcadis to undertake a technical assessment of the converter station to support the planning and land acquisition process. The assessment is also intended for the benefit of stakeholders, in particular Fareham Borough Council as Landowner and RCAM as the Operator of Solent Airport. It will be made publicly available. At the date of issue of this report, a planning application has been submitted, but has not yet been determined.

The scope of work [1] was agreed between National Grid, Fareham Borough Council and RCAM. It is to consider whether the proposed facility once built can co-exist with the existing airport without significantly affecting safe airport operations. Any impact from future airport developments and the overall plans for the area will be considered separately, the latter being part of the planning assessment.

This report details the methodology and output for the technical assessment. A multi-disciplinary approach has been adopted incorporating specialist technical assessment together with hazard identification and risk assessment in order to provide safety assurance to support the planning determination and land acquisition process and to identify any potential issues that will need to be managed as the project lifecycle progresses. This assessment also provides a firm basis to plan future technical assessments and to support the detailed safety analysis to be carried out by the future main contractor appointed for the design and development of the converter station.

This work has been undertaken in compliance with the Civil Aviation Authority (CAA) standards CAP 760 [8] and CAP 738 [7].

2 BACKGROUND

Solent Airport at Daedalus dates back to the First World War, and over time has been used as a seaplane base, a Fleet Air Arm station and a training centre, used by both the RAF and the Royal Navy.

Since being decommissioned as a military airfield in 1996, the airfield fell into disrepair, until it was acquired by Fareham Borough Council a decade later. In 2011, it became one of 24 National Enterprise Zones. The area is divided into two parts:

- the Airport which is largely within Fareham Borough; and
- the waterfront, which is within Gosport Borough.

Located on the Solent shoreline between the villages of Stubbington and Lee-on-the-Solent, Solent Airport has been identified as a key development site for creating skilled employment in the boroughs of Fareham and Gosport. Outline planning permission was secured for a comprehensive investment package across the whole airport and surrounding area, which includes over 50 000 m^2 of commercial development in the Fareham Borough, together with a range of community benefits (e.g. public open space, a park and comprehensive landscaping).

Solent Airport is owned by Fareham Borough Council and operated by Regional and City Airports Management Ltd (RCAM). National Grid, as promoter of the converter station, are a prospective tenant.

Fareham Borough Council describes how it sees the future for its own land interest at Solent Airport in [15] as follows:

"For Daedalus to become a premier location for aviation, aerospace engineering and advanced manufacturing businesses, creating many skilled employment opportunities for local people, which is under-pinned by a vibrant and sustainable airport."

The Solent Airport site is zoned into a number of development opportunities and is currently being promoted for a variety of uses.

At its heart is the Airport that will be retained to enable aeronautical related development. The airport is currently used by a variety of organisations listed in Appendix B; this includes flying / gliding clubs, aircraft maintenance organisations, storage of aircraft and private owners. The Maritime Coastguard Agency (MCA) also operates from the Airport. The airport was granted a CAA Licence in January 2015.

The future plans for the Airport include hangars, facilities, services to attract more corporate, and commercial aviation activities, allowing it to be self-sustaining in the medium term and contribute positively to the local community. A number of infrastructure improvements are being progressed to improve the Airport and it is anticipated that these may stimulate additional volumes of air traffic.

Developments completed to date at Solent Airport are:

- a significant investment has been made in remediation;
- CEMAST College (a Centre of Excellence in Engineering and Manufacturing Advanced Skills Training) was opened in August 2014;
- Fareham Innovation Centre was completed in March 2015, providing quality, affordable office/workshop facilities in a supported environment for small businesses;

- construction commenced in April 2015 to create roads and services for development plots on Daedalus East, as the first phase of commercial development.

2.1 IFA2 Interconnector Facility

National Grid is the British promoter of the IFA2 1000MW high voltage direct current (HVDC) electrical interconnector linking the French and British transmission systems. IFA2 will consist of two HVDC converter stations of similar construction, one sited in each country. The converters are connected by 2 x HVDC cables – underground and subsea – in a defined cable route. There are also HVAC cables connecting the converter stations to the existing electricity transmission grid infrastructure.

Within Great Britain, the converter station will be sited to the north-east of Solent Airport as shown in Appendix D.

HVDC and HVAC cables are proposed to be routed in the same cable corridor to the west and north of the main runway to avoid existing development areas of the Enterprise Zone, and to avoid foreseeable development areas, as outlined in the Fareham Borough Council Vision Document [15].

The AC electricity of the sending country is converted to direct current (DC) electricity at the converter station and then transmitted to the receiving country's converter station, where it is converted back to alternating current (AC) and supplied to the receiving transmission system. The interconnector is capable of importing and exporting electricity depending on requirements at any given time.

The link in its entirety will consist of:

1. a converter station including HVAC connection, adjacent to Tourbe sub-station, near Caen, Normandy in France;
2. HVDC land cable from Tourbe to Merville;
3. HVDC submarine cables from Merville, France to Monks Hill Beach, Daedalus;
4. HVDC land cable from Daedalus coast to the converter station at Solent Airport;
5. a converter station at Solent Airport;
6. HVAC connection (both submarine and underground) from the Converter Station at Daedalus to a National Grid Electricity Transmission (NGET) Substation at Chilling, Hampshire.

Depending on the technology type selected, the nominal DC voltage shall be either 390 kV or 320 kV. The nominal AC voltage shall be 400 kV.

The Voltage Source Converter (VSC) will be housed indoors in separate buildings. The main buildings are the AC Hall, transformer enclosures, DC Hall and the Valve Hall.

3 SCOPE OF WORK

The scope of this technical assessment is to consider whether the proposed IFA2 interconnector facility once built can co-exist with the existing Solent Airport without affecting safe airport operations and to identify any constraints or risks, as part of the planning and land acquisition process. The assessment focusses on current activities at the airport, including flying operations, and also looks ahead by considering (at a high level) the effects of potential future airport developments. Issues identified relating to this may be taken into consideration in planning future developments, and further assessment may be necessary.

The work has incorporated both technical assessment in the specialist areas (in particular EMF/ RFI, Aerodrome safeguarding and wind flow), together with a functional hazard assessment (FHA), which is a recognised safety methodology used in many industries (including aviation and defence) to identify hazards associated with a system and evaluate risks. Within the aviation industry, CAP 760 [8] sets the standard and guidelines for FHA.

The tasks undertaken as part of the technical assessment are summarised below:

- Task 1 Aerodrome Safeguarding - an assessment of the safeguarding of the Airport in accordance with CAP 738 [7], to identify any potential impacts on airport operations (e.g. obstacle limitation surfaces, lighting, and bird hazard management). Any safety impact identified through this task has been assessed through the risk assessment at Task 3B below.
- Task 2 EMF and RFI assessment - an assessment of electromagnetic field (EMF) / radio-frequency interference (RFI) from the converter station, the equipment and HV cables and potential impact on airport and aircraft operation. The assessment includes an independent review of previous assessments commissioned by National Grid [3], [5] and [6]. Any safety impact from any issues identified through this task has been assessed through the risk assessment at Task 3B below.
- Task 3A Wind Assessment - an independent peer review has been carried out of the previous wind effects assessment commissioned by National Grid [4]. Any safety impact on flying operations has been considered in the risk assessment at Task 3B below.
- Task 3B - a Hazard Identification and Risk Assessment study in the form of an FHA to CAP 760 [8] standard. This assesses the impact of the proposals in terms of any increase in risk on airport and aircraft operations, in particular the risk of aircraft crash as well as any other foreseeable hazards / risks. Hazards and risks resulting from this study have been recorded in a Hazard Log.

3.1 Assumptions and Exclusions

This technical assessment has been completed to meet the requirements of the scope of work [1], i.e. it focusses on any impact to existing airport operations. Foreseeable hazards and issues related to the future plans for the Airport and the surrounding area have also been identified as part of this work, and may need to be considered in planning future airport developments and the overall planning process.

An FHA has been undertaken in accordance with CAP 760 [8] and the objectives of this assessment. This is a systematic process that uses an expert group to conduct a structured analysis of a system. Possible ways of managing or mitigating risks have been identified through this process. However, this process does not explore risk control or mitigation options in detail at this stage; this report assumes that appropriate controls and mitigations will be implemented through the subsequent safety management processes. All the hazards and risks identified by this assessment have been incorporated into a Hazard Log. The Hazard Log is a record keeping tool applied to tracking all hazard analysis, risk assessment and risk reduction activities for the complete life cycle of the project and is the key source in which the project's safety risk management activities are recorded., The Hazard Log should be used by National Grid and / or Fareham Borough Council to manage the hazards through to closure during the design and development process. The Hazard Log is generally owned by the project manager for the operating authority and residual risks (requiring operational mitigations) are transferred to the operating authority on completion of the project. The operating authority will be responsible for managing other parties that can influence the risk.

The scope of the FHA was agreed by all participants at the outset of the workshop. This considered all aircraft in communication with the Solent Airport Control Tower, or attempting to be in communication with the Solent Airport Control Tower. Other aircraft using the Class G (uncontrolled) airspace in the vicinity of Solent Airport were excluded from the FHA because the effect of buildings under Class G airspace is addressed by compliance with general regulations. Solent Airport has a CAA licence for current flight operations, but is not an officially safeguarded airport. Requirements for safeguarding are given in Section 6.

The scope of work [1] excludes hazards and issues related to the construction phase of the project. This will need to be considered by the future Main Contractor appointed to construct the facility and the appropriate Safety Management Plans put in place. The Main Contractor should also implement a separate risk register in accordance with the Construction (Design and Management) Regulations to manage construction risks.

The assessment has been undertaken in accordance with the following standards and guidance:

- Civil Aviation Procedure (CAP 738) Safeguarding of Aerodromes [7].
- Civil Aviation Procedure (CAP 760) Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases [8].
- Solent Airport Safety Management System [9].

4 METHODOLOGY

A multi-disciplinary approach has been adopted for the technical assessment, covering a number of specialist areas. The work has required the use of a variety of techniques and methodologies, in particular:

- information gathering and peer review of previous assessments;
- technical assessment;
- aerodrome safeguarding assessment in accordance with CAP 738 [7];
- FHA in accordance with CAP 760 [8];
- independent calculations undertaken to verify assumptions and previous assessments;
- collation of stakeholder views and concerns.

4.1 Information Gathering and Peer Review

At the commencement of this work, National Grid, Fareham Borough Council and RCAM provided access to a library of information via a SharePoint site. This information provided a major contribution to this assessment. The information typically falls into the following categories, which determine how it has been used in the assessment:

- Existing analysis and assessment used to support the onshore planning application forms the basis for the technical assessment of EMF / RFI effects and wind flow as identified by National Grid in the “Information to Support the Scope of Work” [1]. This has been peer reviewed as part of this work (References [3] to [6]).
- Information provided for familiarisation and to inform the study, including the Airport layout, existing and planned airport equipment and location (References [10] to [37]).
- The existing hazard log for the Airport [32].
- Supporting information identified as potentially being of relevance as input to the HIRA study [38] and [40]. This has been reviewed and used accordingly.
- Responses to specific questions raised by Arcadis through a Master Questions List [39].

The list of Information that has been used to support this study is listed in the References.

5 TECHNICAL ASSESSMENT – ASSESSMENT OF ELECTROMAGNETIC COMPATIBILITY

5.1 Introduction

This section of the report presents a technical assessment of Electromagnetic Field (EMF) and Radio Frequency Interference (RFI) compatibility of the proposed converter station and cabling with operations at Solent Airport.

Appropriate considerations for the design of the proposed converter station and cabling should include control measures for EMF and RFI in order to prevent any impact upon electrical equipment and maintain the safety of operations at Solent Airport.

Previous work presented in [3], [5] and [6] has been commissioned by National Grid to investigate the possible effects of EMF and RFI that the converter station and cabling might present at Solent Airport. The assessment documented in this section primarily focusses around an independent peer review of these previous studies, as part of the overall assurance process for the converter station and cabling and their possible impacts upon the operations at Solent Airport.

The preliminary studies were undertaken at the planning stage, when all details of the design of the converter station were not known, hence they included assumptions relating to the design and specifications of the converter station. The assumptions concern parameters and equipment specifications that the calculations may be sensitive to such as voltage, cable types, and cable configuration. This independent peer review has also considered the appropriateness of the assumptions in the preliminary studies. As the detailed design of the converter station progresses and specifications are finalised, the parameters, equipment specifications, and the associated assumptions should be reconsidered, and the conclusions of the assessments re-confirmed.

This independent peer review has also considered at a high level any possible future plans for the Airport and the surrounding area where these are known and recommendations are included accordingly for any future assessment work.

It should also be noted that in parallel with this work, National Grid has commissioned some further more detailed assessment [52] and [53], to develop the preliminary studies in [3], [5] and [6]. Although this work has not yet been finalised it may have a bearing on some of the recommendations raised in this assessment and this is commented on here. It should be noted however, that these were provided very recently to Arcadis and a peer review of these documents has not been undertaken.

5.2 Background to EMC and RFI

Electro Magnetic Compatibility (EMC) means that an electronic or electrical product is compatible and shall function as intended in its environment and shall not generate electromagnetic disturbances that may influence other products (adversely or otherwise). In other words, EMC deals with problems of emission as well as immunity of electronic and electrical products and systems, which could potentially cause electromagnetic disturbances. These can result in conducted interference as well as radiated emissions and immunity problems.

Radio Frequency Interference (RFI) is an electromagnetic disturbance that affects electronic or electrical devices due to either electromagnetic conduction or electromagnetic radiation emitted from an external source. RFI can disrupt and disturb the normal functioning of these devices and thus it is important to limit it where possible. The source of the RFI may be any object, artificial or natural, that carries rapidly changing electrical currents.

In this technical assessment, as in the preliminary studies, the potential influence being considered is the converter station and its associated HVAC and HVDC cabling on operations at Solent Airport, including the impact on aircraft. The focus of the work has been on systems that are related to safety and in this context, the work has supported the Hazard Identification and Risk Assessment described in Section 8.

In the context of the converter station, RFI could potentially be emitted from the converter station during operation and this has the potential to interfere with ground / aircraft communication or navigation systems, which in turn could potentially impact airport operations and in the worst case contribute to an accident (e.g. aircraft crash). In order to mitigate this in the design, the HVAC and HVDC cables will provide shielding from electric fields. The design of the converter station will have to comply with government set guidelines for exposure to EMF. These include IEC standards and CIGRE [50] and [51], also the EU Directive 2013/35/EU, which specifies the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents and electromagnetic fields. Note that HVAC and HVDC cables emit different types of magnetic field and different limits apply.

5.3 Approach of Assessment

Consistent with the scope of work [1], the review has focussed on the following documents:

- RFI assessment report for IFA2 and Daedalus Airfield by LSA Electromagnetics [3];
- IFA2 magnetic field calculations [5] and [6];
- Compass deviation calculator for DC cable 210716 [5] and [6];
- Additional information was obtained from National Grid and FBC with regard to:
  - current and foreseen users of the Airport and surrounding area [16];
  - location of antenna masts and (radio) equipment [36];
  - assumptions and calculations used in the existing reports (telephone conversation with National Grid and LSA Electromagnetics);
  - equipment used including both current and future equipment [35].

Two of our EMC/RFI experts carried out an independent peer review of the preliminary studies provided, in order to verify the assessment and consider the accuracy and completeness of the methods, the assumptions, and to validate their outcomes, or otherwise

Assessments were evaluated against the IEC 61000 standards [51], as well as CIGRE Technical Bulletin 391 [50].

The assessment was conducted in parallel to the consideration of hazards and risks described in Section 8 and the study has both taken information from and informed the risk assessment process. The systems that are critical for airport and aircraft safety were identified through the hazard identification process, which used the CAA risk model as a basis. These systems have been considered within this technical assessment; they include communication, navigation and meteorological systems as identified within the report in [48].

5.4 Overview of Preliminary Assessments

National Grid commissioned a number of preliminary studies to support the planning application process. These provided a preliminary assessment of the extent of any impact from the proposed IFA 2 converter station and the cabling on the Airport operations. In particular, National Grid carried out an assessment of the potential for radio frequency interference (RFI), and concluded that there is a very low probability of interference to airport communications systems and no credible safety risk to aircraft equipment. In these studies, some localised effects were predicted as follows:

- a risk of interference to aircraft receivers operating in areas of the Airport close to the converter station, The strength of the main signal compared to any electromagnetic radiation from the converter station is such that it is not expected to be disturbed;
- deviations of heading indications on compass systems and magnetometers due to DC and power frequency magnetic fields was found to be negligible although some localised impact is expected, mainly for aircraft on the ground close to the HV cables;
- interference to local high-frequency, medium-frequency and low-frequency radios. The assessment of the potential for this found that only those located within 300 metres of the Converter Station may be considered to be at risk of interference.
- an initial assessment of possible shadowing of terrestrial television transmissions for the Rowridge transmitter on the Isle of Wight in [3] concluded that the risk of this is low on the basis that the converter station building is not substantially higher than the residential buildings to the northeast of the converter station location.

National Grid has commissioned further assessment of effects on aircraft systems and equipment, also shadowing of terrestrial television transmissions. These reports have not yet been finalised. Two of these reports have recently been provided to Arcadis in draft form as additional information [52] and [53]. Detailed peer review of these recent reports is outside the Arcadis scope, however they are commented on below.

Reference [52] provides further detailed assessment of television shadowing effects to develop the previous work in [3] and concludes that whilst there is a potential theoretical shadowing effect, the impact is not significant.

Reference [53] has considered further the potential impact of the magnetic fields generated by the HVDC and HVAC cables that are planned for IFA2 on Daedalus Airfield on aircraft equipment and supplements the preliminary analysis in [3]. This confirms the results of the preliminary assessment, which predicted only a localised and temporary impact on magnetic compasses and magnetometers from HVDC cables and overall predicts negligible risk of disturbance or damage to equipment.

5.5 Findings of Assessment and Recommendations

5.5.1 High-Frequency Electromagnetic Interference (RFI)

Arcadis considers the methodology used in the existing assessments carried out for and by National Grid valid (References [3], [5] and [6]) to be acceptable.

As noted above, Arcadis' assessment as well as the previous assessments are based on a range of assumptions. This was necessary and is standard practice when the design of the converter station is at a very early stage and actual detailed design data is not yet available. Additionally the full extent of the plans for the area is not known. Assumptions will need to be verified / validated as the design and plans progress, to enhance the technical justification and to ensure that they remain valid for future systems. In particular, the following points are noted:

- The assessment of RFI emissions [3] has focussed on the interference of the converter station to aircraft systems, covering in particular the safety related systems, and is based on the CIGRE Technical Bulletin 391 [50]. This is considered to be a valid approach. The coverage of the safety systems has been confirmed by the Hazard Identification and Risk Assessment. Consideration should also be given to potential interference to other objects and systems, e.g. businesses, mobile phones, etc. which should comply with IEC 61000 standards. Thus at this stage from the work already undertaken there is confidence that any impact on existing airfield operations is limited and that safety risks are acceptable in line with CAP 760 [8] for existing airfield operations. However further work is recommended as the project lifecycle progresses and plans develop to consider these other systems
- Reference [3] (Chapter 6) has considered the main potential safety related communication systems. In particular, it recognises that further detail is required of the receivers at the Maritime Coastguard Agency. The MCA mast is far enough away (about 1000 m) from the converter station not to be affected by it. Thus for the existing users of the Airport there are no issues raised. There is a recommendation raised however to re-consider the potential effects should any new tenants with equipment potentially sensitive to electromagnetic emissions be introduced to the Airport. For any future tenants (not already identified in Appendix B), it needs to be confirmed that there is no impact on any equipment they may introduce and consideration given to where they are located i.e. distance from the converter station.
- Regarding Digital Television Reception Reference [3] concludes that the risk of shadowing of the digital televisions transmission is low, however it recommends that a more detailed analysis be undertaken. More detailed assessment has recently been completed in [52]. The detailed assessment concludes that there is a potential theoretical shadowing effect but that the impact is not significant. It should be noted that this has considered the effects of the physical ‘shadow’ and not any effects of interference by the converter station. It is expected that these effects will be limited; however, it is recommended that a future assessment considers variations in the signal strength of the digital television signal and whether this can be disturbed or suppressed by the emissions of the converter station.

5.5.2 DC and Low-Frequency Interference

Regarding static magnetic fields effects, Excel calculation sheets [5] and [6] have been provided, predicting the expected compass deviation as a function of source, depth of the source in the soil and currents. These calculations were found to be acceptable and in line with standard practice. The assessment of magnetic fields is sensitive to design parameters assumed e.g. cable design and cable type, hence it is recommended that these calculations be re-confirmed and, if necessary, developed further as the design and future plans progress. It is recommended that the eventual justification report includes description of the methodology adopted as well as the calculations, and indicates the possible spread of plausible values of the input parameters if they are not precisely known yet, supplemented with the conclusions regarding the risk of excess compass deviation.

Regarding the potential for power frequency interference, Reference [3] concludes that, based on a comparison of a typical aircraft length (tens of meters) with the frequency at 50 Hz (6000 km wavelength), the influence (“potential difference”) would be negligible. Arcadis agrees that any impact is limited and that any safety risk is acceptable as defined in CAP 760[8]. It is recommended that future assessment considers power frequency induced voltages and potential-to-earth effects as the detail design of the converter station and cables progresses to rule out any risks. This should also confirm that there are no other 50 Hz sources that could potentially cause inductive effects. National Grid is progressing the recommendation for further assessment, in particular the recent draft assessment in [53] develops the considerations of any impact on aircraft equipment and confirms the results of preliminary assessments [3] with no additional issues raised.

5.6 Future Plans

The conclusions of the existing reports focus on the Airport main runway and existing airport operations. This is also the scope of this assessment [1]. Any RFI and EMC aspects for other future systems and buildings (commercial, residential) in the vicinity of the convertor station or the cable route will also need to be demonstrated. As an example, close to the interconnector, spaces are allocated that are intended for future small, light-industrial users, one of which may be a “precision engineering company”, whose activities are not specified. It is recommended that Fareham Borough Council consider any EMC sensitivity parameters for any future businesses (not identified in Appendix B) who may be engaged in activities such as meteorology, calibration, precision-fabrication and production, scanning, etc. in order that these can be objectively assessed with National Grid.

5.7 Conclusions

The assessment of EMF and RFI effects is undertaken at the planning stage when the details of the design of the converter station have not yet been finalised in the design specification. Hence it is based on a number of assumptions, consistent with the preliminary assessment in [3] which are considered to be reasonable, but will need to be validated as the design progresses.

The assessment concludes that within the scope of this study (i.e. impact on existing airport operations) the risks from EMF and RFI effects is expected to be acceptable as defined by CAP 760 [8]. All actions relating to mitigation measures identified to ensure risks are acceptable are recorded in the Hazard Log to be managed and tracked to closure over the project lifecycle.

Analysis undertaken so far has focussed on the existing airport operations and in particular the safety systems. Recommendations are given (Section 9.4) to develop the analysis as the design progresses in order to provide a robust safety and technical justification for EMF and RFI effects and confirm that risks are acceptable as defined in CAP 760 [8].   Additionally, the assessment has taken into consideration future plans for the Airport and the surrounding area where they are known, with recommendations for the ongoing planning process further assessment work in the future.

National Grid are taking forward these recommendations for further assessment; recent detailed assessments have been completed or are in hand to consider in more detail impact on digital television signals, aircraft equipment and specific stakeholder interests, and they are considering implementing a practical communication interference test.

6 TECHNICAL ASSESSMENT – AIRPORT SAFEGUARDING

This section of the report analyses the IFA2 Interconnector Facility, focusing on the associated buildings of the converter station, against Aerodrome Safeguarding criteria. The section introduces the concept of Aerodrome Safeguarding, its context in relation to the IFA2 Interconnector Facility and any recommendations or mitigation measures required arising from the assessment.

6.1 Purpose of Aerodrome Safeguarding

The primary purpose of aerodrome safeguarding is to protect aircraft from obstacles and obstructions whilst operating in the vicinity of airports. With regards to airports the purpose is to take measures to ensure the safety of aircraft, and thereby the passengers and crews aboard them, while taking-off or landing, or while flying in the vicinity of an aerodrome. Thus, measures are taken to prevent aircraft colliding with each other, or with fixed and mobile objects, while manoeuvring on the ground, while taking-off or landing, or while flying in the vicinity of the aerodrome. Measures are also taken to prevent interference with, or distortion of the guidance given, or indications from visual aids, radio aids to air navigation and meteorological instruments. It also includes the measures taken to reduce the risk of aircraft experiencing a bird strike, particularly during take-off and landing.

This is achieved by a process of checking proposed developments to:

- protect the blocks of air through which aircraft fly, by preventing penetration of surfaces created to identify their lower limits;
- protect the integrity of radar and other electronic aids to air navigation, by preventing reflections and diffractions of the radio signals involved;
- protect visual aids, such as Approach and Runway lighting, by preventing them from being obscured, or other lights being confused for them;
- reduce the hazard to aircraft from bird strikes, by preventing the increase of bird numbers in the vicinity of the aerodrome.

Safeguarding is included in UK legislation as an integral part of the planning procedure. It is set out in Directions contained in circulars issued under the Town and Country Planning Acts. Local Planning Authorities (LPAs) are advised, usually by issue of maps, of the safeguarded area around an aerodrome. Normally these extend to some 15 km from the aerodrome. The LPAs are required to approach the Safeguarding Consultee named on the map (usually the aerodrome concerned) about any Planning Application within this area, should it meet certain criteria relating to the height and location of the proposed development to the aerodrome. In addition, any proposed developments with bird attractant properties within 13 km of the aerodrome will also be referred for consultation. The reason for the 13 km area is explained in Section 6.7.

An explanation of the legislation in relation to Solent Airport is provided in Section 6.5.

6.2 CAP 738 – Safeguarding of Aerodromes

Civil Aviation Publication – CAP 738 [7] is a guidance document produced by the CAA for airports and those responsible for the safe operation of an aerodrome or a technical site. It describes the processes and procedures that should be followed when assessing the impacts on aerodrome and aircraft operations against new development proposals. There are a range of factors that must be considered when planning developments in the vicinity of an airport or aerodrome and CAP 738 is the main point of reference in the UK for these issues. CAP 738 includes a Safeguarding Process Flowchart (Chapter 1, Page 3) as a guide for ensuring the correct procedures are followed when assessing developments.

CAP 738 contains the relevant information within which the IFA2 Interconnector Facility at Solent Airport is assessed against Aerodrome Safeguarding criteria. The main aspects of the assessment cover the following broad areas:

- Obstacle Limitation Surfaces;
- bird strike hazard;
- lighting;
- cranes.

To provide overall context to CAP 738 there are several other measures to analyse, as follows:

- technical site safeguarding;
- wind turbines;
- roads & railways.

Technical Site Safeguarding analyses the impact of development on aeronautical systems. This assessment is described in the following sections. Wind turbines can interfere with air navigation systems by appearing as aircraft on radar screens. No wind turbines are proposed in this application and this is not relevant as part of the study. Road and railways vehicles are considered as potential obstructions to aircraft and are classed as mobile obstacles. However, due to the nature of the proposed development the IFA2 Interconnector will have no impact on adjacent roads or railways.

6.3 The Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction 2002

The Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage areas) Direction 2002 [41] is the UK Government guidance on the management and implementation of the aerodrome safeguarding process through the planning system. It sets out the main processes that must be followed to ensure that appropriate consultation is undertaken for developments in the vicinity of aerodromes and other technical sites related to aviation, such as radar installations.

Civil aerodromes in the UK are licensed under an Air Navigation Order made under section 60 of the Civil Aviation Act 1992 [42]. The CAA is responsible under the Air Navigation Order for being satisfied that a licensed aerodrome is safe for use by aircraft. Part of this provision includes being satisfied that the physical characteristics of the aerodrome and its surroundings are safe to use by aircraft.

Some of the key aspects of the town and country planning (safeguarded aerodromes, technical sites and military explosives storage areas) direction 2002, which will need to be considered for the IFA2 interconnector at Daedalus, include the Safeguarding Map, Officially Guarded Aerodromes, Other Aerodromes, and the Aerodrome Information Package. These are described in more detail in subsections 6.3.1 to 6.3.3 below.

6.3.1 Safeguarding Map

The need for and purpose of the safeguarding map is described in the legislation [41]. A safeguarding map for individual aerodromes is lodged with relevant local planning authorities to indicate the type of development they must consult on. The safeguarding map is centred on the aerodrome and contains colour-coded areas showing the extent of the safeguarded area to indicate the appropriate developments to refer for consultation. The colour coding within the map largely refers to the height of proposed buildings and structures that will trigger the required for a consultation.

6.3.2 Officially Safeguarded Aerodromes

There are a number of officially safeguarded aerodromes in the UK, largely due to their importance to the aviation industry and overall transport system.

All major airports in the UK are officially safeguarded and this is to ensure that they can continue to operate safely and efficiently without being inhibited by buildings, structures, physical objects and any other feature that may obscure runway lights or impair the performance of navigational aids.

Generally, all development within the safeguarded area, which is broadly the extent of the Obstacle Limitation Surfaces (OLS), must be referred to consultation with the relevant airport. Officially safeguarded aerodromes are included in the list of statutory consultees within the planning system.

Local Planning Authorities will refer to the safeguarding map when deciding whether or not to consult on a particular development.

6.3.3 Other Aerodromes

In addition to the officially safeguarded aerodromes, there are many other aerodromes in operation around the UK. These are typically small to medium sized airports and airports. They do not experience the same level of protection under planning legislation as officially safeguarded aerodromes.

However, best practice advice for other aerodromes is to establish a process to protect the safe and efficient operation of the aerodrome against new development. Measures should be taken to agree on consultation procedures between the aerodrome and local planning authorities.

These aerodromes do not have official safeguarding maps but the CAA recommends that an unofficial safeguarding map be lodged with the relevant local planning authorities and that local authorities act reasonably towards non-officially safeguarded aerodromes when assessing new development.

6.4 Aerodrome Information Package

The Aerodrome Information Package contains relevant aeronautical information and general airport information on a particular airport or aerodrome. The AIP for Solent Airport is published as Lee-on-Solent under the International Civil Aviation Organization (ICAO) Code EGHF. With regards to safeguarding, the information in the AIP is used as background data for completing the safeguarding assessment. The AIP contains important data on the position and height above mean sea level of the Aerodrome Reference Point (ARP). The ARP is the main point of reference for the geographical location of the Airport. The ARP is usually situated on the mid-point of the main operational runway.

The ARP also states the important lengths and dimensions of the runway.

Using this data from the ARP enables us to obtain the relevant information required to input into the safeguarding assessment, particularly when assessing the building heights against the obstacle limitation surfaces, which is discussed in section 6.6.

6.5 Solent Airport

Solent Airport is not currently an officially safeguarded aerodrome and the legislation explained in previous sections is not strictly applicable to the Airport. Therefore, developments are not automatically required to be referred for a formal consultation.

Solent Airport is categorised under the definition provided in Section 6.3.3 Other Aerodromes. As such, no official safeguarding map is required, nor is there an obligation to consult on local planning applications. Any safeguarding process is advisory.

However, it is clear that due to the management and ownership status of the aerodrome that there is an effective process in place for safeguarding to ensure development in the surrounding area and within the aerodrome boundary itself.

It is evident that an aerodrome safeguarding process is in place to ensure that new development does not adversely impact the operation of the Airport. The assessment completed in this study follows the principles described above.

6.6 Obstacle Limitation Surfaces

Obstacle Limitation Surfaces (OLS) form a complex series of 3-Dimensional surfaces, which vary depending on the characteristics of the runway and are fully defined in ICAO Annex 14 and Chapter 4 of CAP 168.

They extend upwards and outwards from the edges of the Runway Strip and/or Runway Clearway and comprise the following:

- Take-Off Climb Surfaces;
- Approach Surfaces;
- Transitional Surfaces (sometimes called “side slope”);
- Inner Horizontal Surface;
- Conical Surface;
- Outer Horizontal Surface.

The surfaces are shown in Figure 1 below.

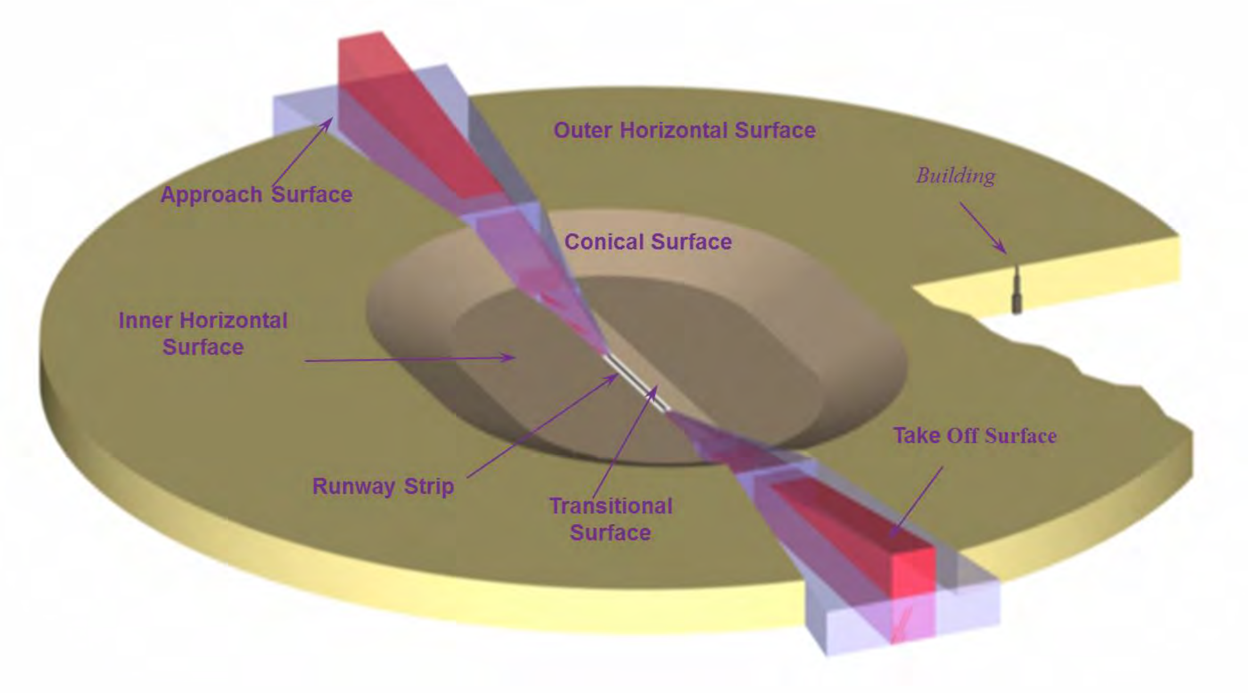

Figure 1 – Obstacle Limitation Surfaces

The requirement is that no new objects penetrate these surfaces, unless shielded by an existing immovable object. These surfaces apply to aircraft parked on aprons, but not to those taxying.

Additionally, there is a set of inner obstacle limitation surfaces, which together make up the Obstacle Free Zone (OFZ). They have the object of protecting an aircraft making a precision instrument approach and during any subsequent missed approach from both fixed and mobile obstacles. The OFZ comprises the following:

- Inner Approach Surface (a portion of the Approach Surface);
- A portion of the Runway Strip;
- Inner Transitional Surface;
- Baulked Landing Surface.

No object, whether fixed or mobile, is allowed to penetrate the OFZ, unless it is frangible and its presence is essential to air navigation. However, if the main Obstacle Limitation Surfaces, listed above, are not penetrated by a fixed object, then neither will these surfaces. Therefore, these surfaces mainly apply to mobile objects, such as aircraft using the taxiway system, particularly to aircraft at the runway holds awaiting entry to the runway.

Solent Airport does not currently have Instrument Landing Systems (ILS) installed and as the primary objective of the OFZ is to protect aircraft making a precision approach, this does not strictly apply to the Airport at this time. However, the understanding is that whilst there are no foreseeable plans to introduce ILS at Solent Airport, the possibility cannot be discounted. Nevertheless, the OFZ is less onerous than the other surfaces and if these are protected and free from obstacles then the OFZ will be protected by default.

Finally, the Plane of Approach Lights is a surface, or more commonly, a series of surfaces, based on the heights of the individual lights in the approach light system, and is established to ensure that objects do not obscure or distort the lighting pattern observed from aircraft on the approach.

The plane extends from the threshold to 1.5 times the length of the system at a width of 120m equally disposed about the extended centreline of the runway. The gradient of the section beyond the outermost end of the system is an extension of the surface joining the threshold lights and the outermost light.

Solent Airport does not currently have approach or runway lighting installed so this does not apply to the Airport. However, these may be installed in future upgrades and this must be considered within the context of developing the wider site.

6.6.1 Assessment

The closest point of the proposed National Grid development at Solent Airport is located just under 1km from the ARP and therefore is situated within the OLS. The AIP states that the ARP is 9.95m above mean sea level.

Figure 2 (also included in Appendix C) illustrates the position of the buildings in relation to the Airport and the OLS.

Figure 2 – Position of Buildings in relation to Airport and OLS

Figures 3 and 4 (also included in Appendix C) illustrates the location of the buildings in relation to the OLS in further detail.

Figure 3 – Position of Buildings in relation to OLS with background image

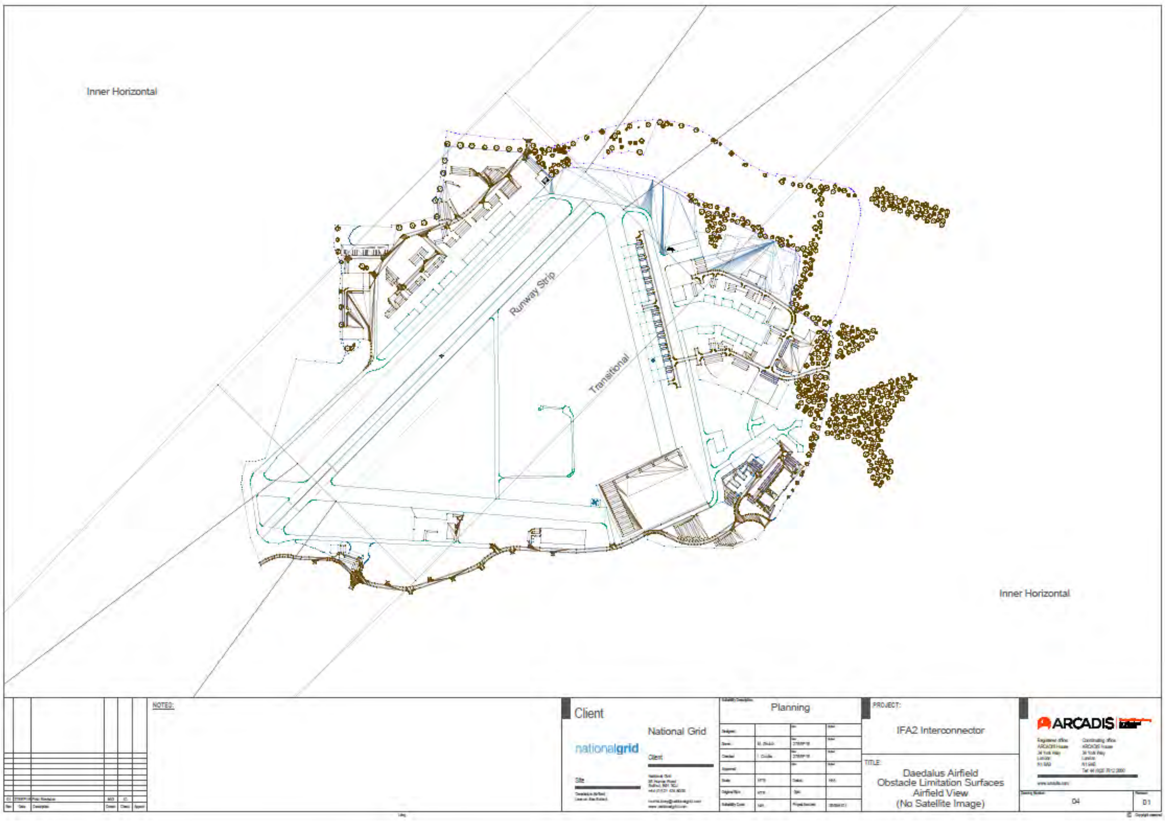

Figure 4 – Position of Buildings in relation to OLS without background image

Figure 5 shows the location of the Transitional and Inner Horizontal Surfaces in relation to the runway. The IFA2 Interconnector buildings are situated within the both the Transitional Surface and the Inner Horizontal Surface. The buildings are not situated underneath any of the other surfaces.

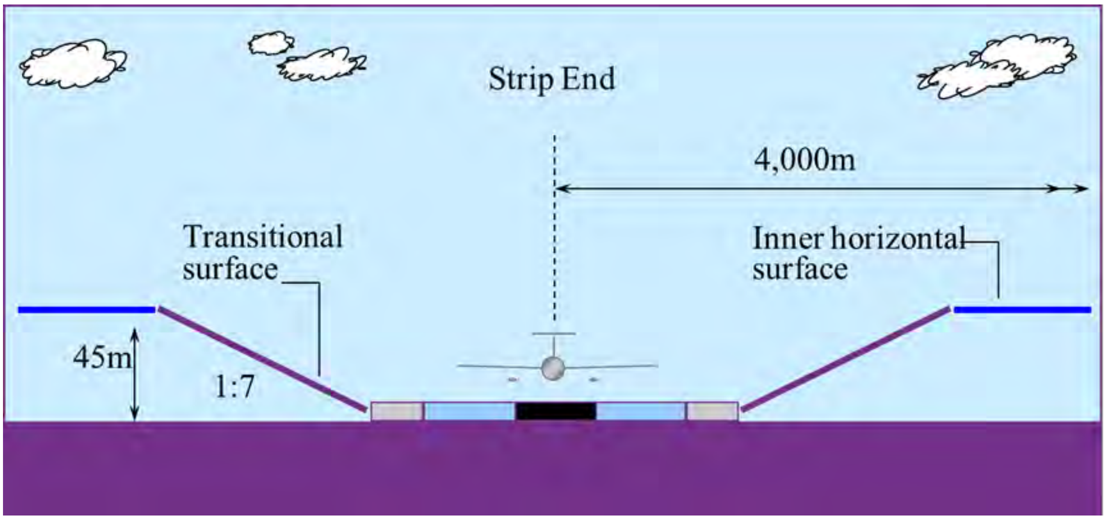

Figure 5 - Transitional and Inner Horizontal Surfaces

The Transitional Surface is a sloped surface rising 1:7 from the edge of the runway strip. It slopes up until it meets the Inner Horizontal Surface (IHS). The IHS is a horizontal surface located 45m above the surface of the ARP.

There are various different independent and connected buildings proposed within the site. However, the maximum height of the buildings is 22m above ground level.

6.6.1.1 Transitional Surface

A portion of the development site is situated within the Transitional Surface and as described in the previous section, this is a sloping surface beginning at the edge of the runway strip and ending where it meets the Inner Horizontal Surface 45m above ground level. The assessment has analysed the building closest to the most onerous section of the transitional surface and determined that it is situated under the maximum height that would create an infringement.

The height of the corner of the building closest to the most onerous section of the transitional surface is 14m below the transitional surface. The height of the transitional surface at this point is 36m. This clearance increases for the buildings situated further away from the runway. Therefore, the development will not create an infringement of the transitional surface.

6.6.1.2 Inner Horizontal Surface

All new developments including buildings, vegetation and other obstacles must not exceed 45m above ground level. Anything higher than this would create in infringement of the OLS. The maximum height of the buildings is 22m, therefore the new buildings will not create an infringement of the OLS.

The location of the converter station in relation to the relevant OLS described above is illustrated in Figure 6 (also included in Appendix C). This demonstrates that the buildings will not infringe the surfaces and will therefore have no impact on the OLS.

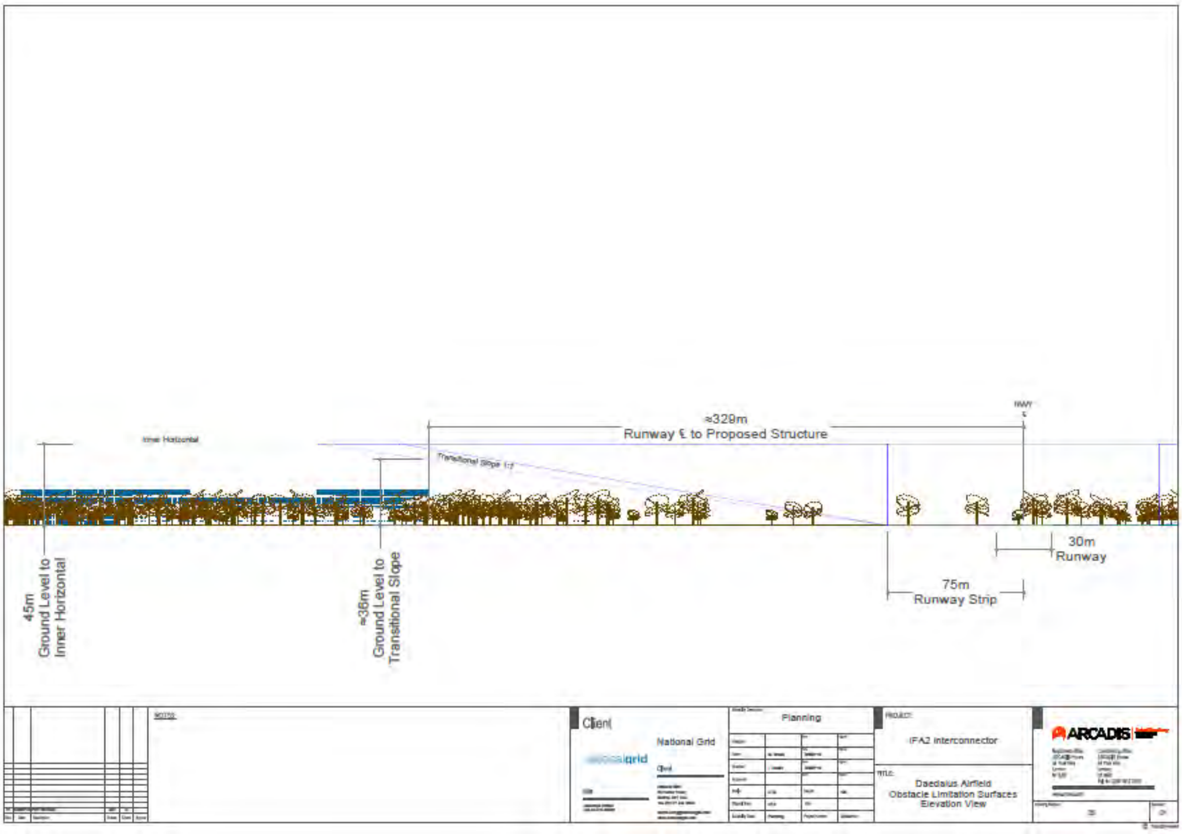

Figure 6 - location of the Converter Station in relation to the relevant OLS

6.6.1.3 Landscaping

The plans indicate that landscaping and trees are proposed within the development. It is extremely unlikely that the trees will be taller than the buildings so no infringement is likely. Once established the trees will continue to grow but they would need to be 45m in height before creating an infringement.

It is likely that other vegetation in the surrounding area that is more established will be an issue before the new trees on this site so they are not considered to be an issue from the perspective of the OLS. Regular pruning should be undertaken on surrounding vegetation if it is considered a risk to a potential infringement of the OLS. This is recorded as a contributory factor and action for ongoing management in the Hazard Log [48].

6.7 Bird Strike Hazard

Bird strikes – collisions between birds and aircraft – have been around since the dawn of aviation. The first bird strike fatality was recorded in 1912 when Cal Rogers, the first man to fly across America, lost his life after a gull became jammed in the controls of his aircraft. Since then more than 190 deaths have resulted from over 50 crashes of civil aircraft and over 300 military aeroplanes have been lost following bird strikes. The cost to the civil aviation industry worldwide is estimated to be over £750 million per year in damage and delays.

Aircraft are particularly vulnerable to collisions with large birds such as waterfowl and flocks of small and medium sized birds such as starlings and gulls. Most bird strikes take place when aircraft are below 2,000 ft., thus they are most susceptible when approaching to land at an aerodrome or shortly after take-off. Aircraft up to 13 km from an airport may be at this altitude; therefore, the aerodrome safeguarding process at airports will assess all developments within a radius of 13 km against the risk of bird strikes. It is essential that features attractive to birds are not introduced to the aerodrome or the surrounding environment unless they are proactively managed and monitored.

Provided certain bird attractant features are avoided, it is possible for landscaping proposals, including water features, to be acceptable to the aerodrome safeguarding process. Similarly, there are certain bird attractant properties in building design that should not form part of the design for buildings on or near an aerodrome. This applies to all developments at Solent Airport.

The main issue in building designs are flat or low-pitched roofs. These provide an ideal environment for loafing, roosting and nesting. The best way to mitigate this risk is to avoid flat or low-pitched roofs in the design of the building. However, this can be unavoidable in certain circumstances due to the nature of the development and the operational requirements of the building. Advice from the Airport Operators Association (AOA) states that flat or shallow pitched roofs should not be greater than 10m x 10m. If this cannot be avoided in the design then all parts of the roof should be accessible by foot to ensure that any hazards arising from birds loafing, roosting and nesting can be dispersed and any eggs or nests can be removed.

6.7.1 Assessment

The first point of reference for airports regarding the management of wildlife on and surrounding the Airport is CAP 772 – Wildlife Hazard Management at Aerodromes.

The proposed development includes various buildings of different sizes, some of which are connected to each other. Each building has a flat roof and taken together they form a large surface area.

Assuming the design of the building cannot be changed due to the nature of the development the recommendation is that all areas of the roof can be accessed by foot and regularly inspected. It is essential to design this from the outset as retrofitting rooftop access can often be problematic leading to ineffectual bird strike hazard measures.

Consideration should also be given to the development and active management of a bird hazard management plan (BHMP) due to the location of the site in close proximity to the Airport. There are several buildings proposed for this development and they are located in close proximity to each other. Therefore, one consolidated BHMP would be sufficient to manage all of the buildings. The BHMP will detail the inspection regime and activities undertaken to manage the risk of birds loafing, roosting and nesting on the roofs of the building. Given the nature of the development, it is assumed that there will be a permanent or regular on site presence and that the buildings will be well maintained. A nominated person should be responsible for the plan.

The plans indicate that landscaping and trees are proposed within the development. As particular varieties of trees and vegetation can attract birds, it is recommended that these are omitted from the landscaping plans to reduce the bird strike risk. However, if this is not feasible or desirable then the species should not be berry bearing, as berries are an attractant to birds. Regular inspection of the landscaping should be undertaken to ensure that no nesting is taking place.

6.8 Lighting

The approach and runway lights are protected by provisions in the Air Navigation Order [42] which states that other lights shall not be installed which are liable to endanger aircraft taking-off or landing, or which are liable to be mistaken for an aeronautical light. Situations that may endanger are:

- Where intensity causes glare in the direction of an approaching aircraft;
- Where the colour could cause it to be mistaken for an aeronautical ground light (AGL);
- Where, when viewed from the air, they make a discernible pattern similar to AGL;
- Where the overall amount of illumination detracts from the conspicuousness of the AGL.

It is outside of scope of work for this project but it should be noted that outdoor light displays, particularly those involving lasers, searchlights or fireworks, are also of concern if in the immediate vicinity of an aerodrome, or under one of the approaches, and should be notified to the CAA. Advice is available from, and notification of displays should be sent to the Airspace Utilisation Section, Directorate of Airspace Policy / CAA.

6.8.1 Assessment

The main consideration regarding lighting for the IFA2 Interconnector is the location and positioning of lights on the buildings and immediate surroundings, such as car parks. Airport lighting is not currently installed at Daedalus and no night time flying is currently permitted, but it is acknowledged that this may be a possibility in the future as there is a desire to extend operations to allow flying in the hours of darkness. Therefore, whilst lighting within the converter station compound would not obscure future runway lighting it could potentially distract pilots operating at the Airport.

Consideration must be given to possible lighting of the Airport in the future and it would be prudent to ensure the any lighting proposed on the development site must not obscure potential future airport lighting. The most effective method of ensuring that the lighting does not create operational issues for the Airport is to use downward pointing lights with no or very limited light spillage. The AOA recommends [43] that flat glass full cut-off lanterns mounted horizontally be used. This will ensure that no light is emitted above the horizontal.

The AOA also reference the British Standard Institution's BS 5489 Code of Practice for the design of road lighting [44]. This recommends the use of lighting conforming to the maximum luminous intensity of lighting. Each class in Table 1 below is compliant with the flat glass full cut-off lighting principle. Ensuring the lighting design complies with this standard will protect potential future runway lighting and minimise pilot distraction from ground lighting.

It should also be noted that the same requirements apply to all buildings within proximity of the airfield and this is not unique to the buildings in the converter station compound.

Angle from the downward vertical	Maximum Luminous Intensity (cd / klm)		
	Class G4	Class G5	Class G6
70°	500	350	350
80°	100	100	100
90°	10	10	0
>95°	0	0	0

Table 1: Airport Operators Association: Safeguarding of Aerodromes, Advice Note 2 – Lighting near Aerodromes, p.2

As the converter station buildings will not penetrate the Obstacle Limitation Surfaces there is no requirement to install aviation-warning lights on the structures.

6.9 Cranes

Normally cranes, and other items of construction equipment, are not subject to the Planning Application Process, unless this aspect is made a Condition of the Planning Permission for the development. In addition, cranes may be required for other purposes not involving new developments, such as maintenance and repair of existing structures. The British Standard Code of Practice for the Safe Use of Cranes [45] contains the following paragraph:

"9.3.3 Crane control in the vicinity of aerodromes/airports

The appointed person should consult the aerodrome/airport manager for permission to work if a crane is to be used within 6km of the aerodrome/airport and its height exceeds 10m or that of the surrounding structures or trees."

NOTE The Air Navigation Order [42] makes it an offence to act recklessly or negligently in a manner likely to endanger aircraft.

Most airports in the UK have a crane authorisation process involving the issue of Permits, covering both cranes on the Airport and in the area covered by the British Standard. It is essential to consider this at an early stage of the development if it is anticipated that a crane will be required during construction. This is particularly important for the use of fixed cranes that cannot be removed or lowered quickly at the request of the Airport.

6.9.1 Assessment

The issue of cranes is more of a construction issue than a planning issue at this stage but it should be considered as early as possible as it may impact on the construction method and programme. Cranes may be a particular issue, south of the main runway where temporary cranes may be necessary to install drilling equipment. Early consideration must be given to the type of crane anticipated.

Within the 6 km crane circle, it is usually best practice to operate cranes that are capable of being lowered on request within a reasonable period of time. Fixed cranes not capable of being lowered, particularly within or near the approach and take-off areas should generally be avoided. Fixed cranes within the 6 km circle but outside of the main approach and take-off areas can be acceptable provided close cooperation and coordination is in place between the Airport and the crane operator.

Air traffic movements at Solent Airport are dominated by Visual Flight Rules (VFR) traffic so in periods of low visibility airport movements are suspended, particularly as precision approaches are not currently possible. Therefore, any cranes situated in the vicinity of the Airport should be visible to aircraft operating in the area.

The height of cranes may infringe the OLS and in this case, cranes over 45 m in AGL would result in an infringement of the IHS. However, as this is a temporary object this is generally accepted provided the appropriate information is promulgated via standards aviation communications, notably through the issuing of a Notice to Airmen (NOTAM).

6.10 Conclusion

The IFA2 converter station has been assessed against Aerodrome Safeguarding criteria. The aim has been to ensure that the proposals do not currently impact on the safe and efficient operation of the Airport and as far as is practical, ensure that future developments on the Airport itself will not be impacted by the proposals.

The assessment analysed the new buildings against the OLS. The buildings are situated within the Transitional Surface and the Inner Horizontal Surface but at a maximum of 22 m in height, the buildings will not create an infringement.

The main issue regarding bird strike hazard is the flat roofs of the development. However, it is recognised the design may be required for operational reasons. The site will be well managed and there is a good relationship between the Airport and surrounding operators so the measures outlined in the report will be sufficient to ensure that the risk is at an acceptable level as defined by CAP 760 [8]. This is recorded as an action in the Hazard Log for the management of the converter station.

Lighting within the development should follow the AOA advice to ensure that the operation of the Airport is not adversely impacted.

The use of cranes during construction is a temporary measure but the type of crane used should be considered and agreed with the Airport at the earliest opportunity, particularly as the site is in such close proximity to the runway.

Overall, the plans for the IFA2 converter station will not conflict with aerodrome safeguarding criteria. There are a few minor issues to consider when developing the final plans but the general principle of the development to date is considered acceptable and will not adversely impact on the operations of the Airport.

7 ASSESSMENT OF WIND EFFECTS

7.1 Introduction

This section of the report assesses the impact of the proposed IFA2 converter station on wind flow. A preliminary qualitative assessment of the likely impact of wind flow encountered at Solent Airport was commissioned by National Grid [4]. Arcadis has carried out a peer review of this report in terms of the verification of the prevailing wind directions and speed and verification of the impact of the building on wind flow.

Some preliminary analysis of the wind flow has also been undertaken. This analysis is considered to be a bounding case, with pessimistic assumptions in terms of distance from the runways (disused and main runways), the wind direction and wind speed. The analysis has also assumed the layout of the site and dimensions in [11], which are the main buildings of the converter station. National Grid are planning additional analysis to further examine the sensitivity of these parameters.

The outcome of the review is presented below.

7.2 Prevailing Wind Direction and Strength:

The reported wind roses discuss the most common wind situations in terms of wind speeds and directions. However, in addition to this, it is also worthwhile analysing some worst-case scenarios in terms of maximum wind speeds and changes in wind conditions in the future.

The Centre for Energy and the Environment at the University of Exeter conducted research for a multi-disciplinary EPSRC funded project called PROMETHEUS. The main aims of the project were to create a methodology for the creation of a probabilistic future reference year based on weather data using UKCP09 (gridded observation data sets). Such models can be used to identify the problems that new buildings may face as a result of climate change, therefore, assisting the building sector adapt to the challenges of climate change. The closest location in terms of available outputs for Solent Airport is Portsmouth, the wind data for which are analysed as follows.

7.2.1 Current Wind Data vs. Future Wind Data

Figure 7 below shows a basic comparison of wind data in Portsmouth between the present-day and the predicted future. Such wind data is generally taken at the height at which meteorological wind speed was measured, which is a standard of 10 meters.

Both scenarios are considered to be fairly similar to the Solent Airport site-specific wind rose provided by the Meteorological Office, the main difference being the possibility that there will be more westerly winds in the future.

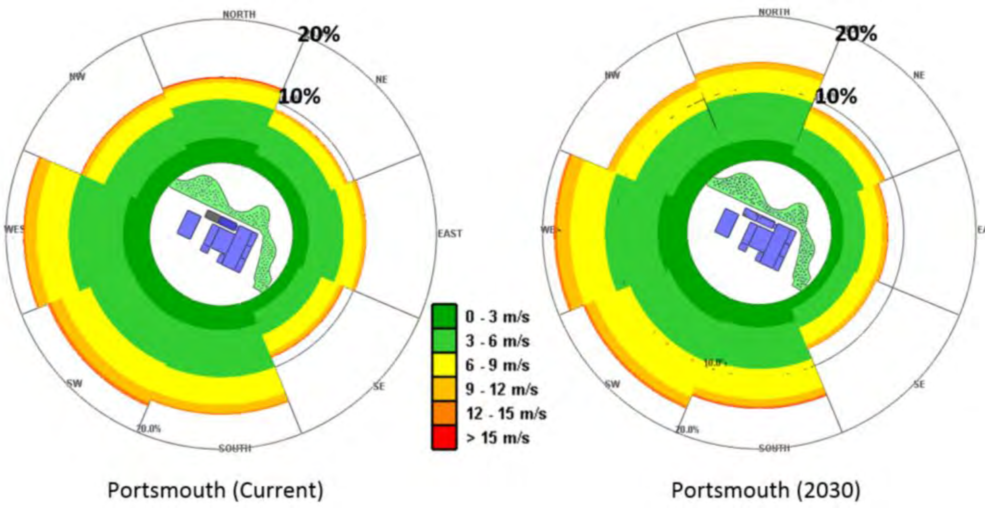

Figure 7 - Wind Roses-Portsmouth

This wind data is analysed in greater detail in the following section.

7.2.2 High Wind Speed Analysis (Current Wind Data vs. Future Wind Data)

Figure 8 below shows a comparison of wind speeds (and the associated directions) that exceed 15 m/s in Portsmouth between the present-day and the predicted future. Both scenarios show that the wind speeds can potentially exceed 19 m/s, although this is considered to be infrequent. It is noted that in the future there are potentially more higher speed south-westerly winds.

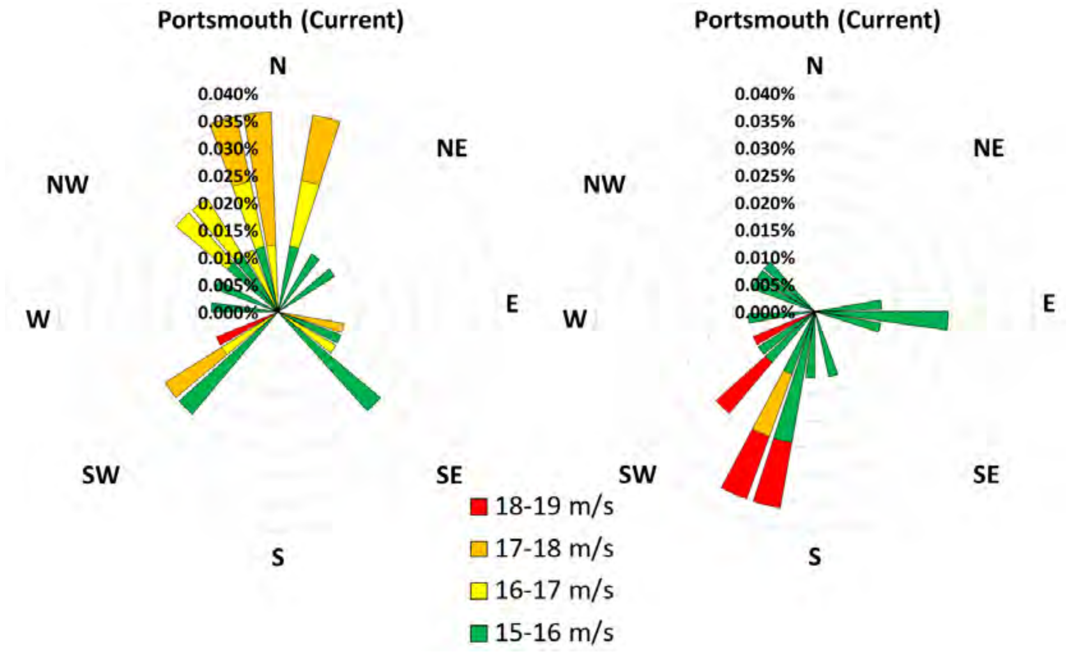

Figure 8 – High Speed Wind Roses-Portsmouth

The analysis illustrated in Figure 8 generally indicates that wind speeds can potentially exceed 19 m/s. The hourly data cannot account for the odd wind 'gusts' which can easily be in the range of double the hourly recorded wind speeds.

Figure 9 below illustrates that the maximum wind speed at an angle of 75^0 does not exceed 16 m/s, and wind speeds ranging from 10m/s to 16m/s only occur for a total period of 36 hours in the whole year. An angle of 75^0 has been selected as a bounding case as explained in Section 7.2.3 below.

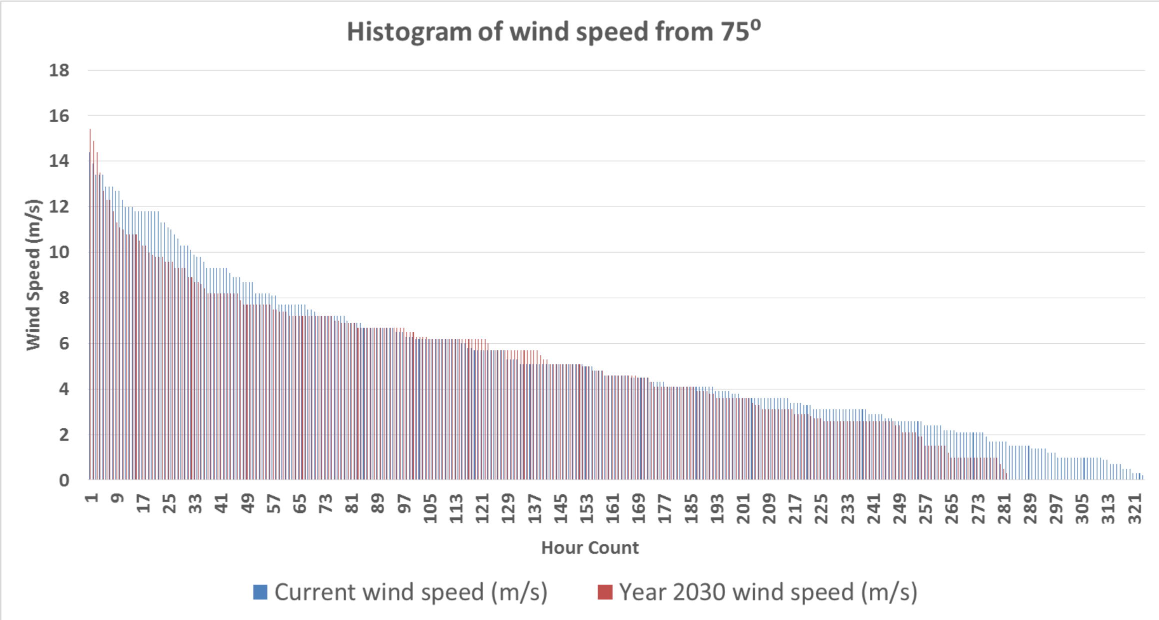

Figure 9 – Histogram of wind speeds coming from 75° for current and future wind data

7.2.3 Impact of the IFA2 Converter Station on Wind Flow

Based on the wind analysis above, it is necessary to understand the impact of potential 'worst case scenarios' of the IFA2 converter station on the trailing winds.

Figure 10 below shows the assumed wind direction (green arrow) that can have the most impact on the Airport in terms of interference of the IFA2 converter buildings with the air flow. This assumption is based on proximity, derived by finding the closest point from the IFA2 converter station site to the disused runway (dotted red line), which is approximately 200m away. The main runway is even further away at 314m, hence the disused runway represents a more pessimistic case than the main runway in terms of the wind effect. A wind flow direction of 75° is assumed which is perpendicular to the disused runway and potentially has the worst case impact because it is closer than the main runway. Additionally, a pessimistic wind speed of 20m/s has been assumed which takes accounts of wind gusts as described in Section 7.2.2.

The main runway has not been specifically modelled in this analysis as it is further away. However, given the combination of the pessimistic assumptions considered in the analysis, the results presented below are expected to bind those for the main runway.

7.2.3.1 Disused Runway (Worst Case Scenario)

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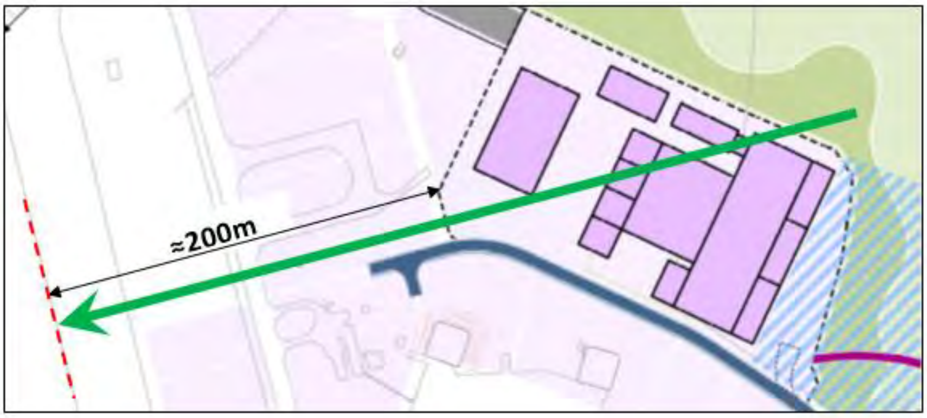


Figure 10 –Worst Case Wind Direction

The impact of the IFA2 converter station on the trailing winds can be better understood using numerical modelling such as CFD (Computational Fluid Dynamics) analysis. The following two sections show the impacts of the buildings on wind with ‘worst case’ assumptions using a wind speed of 20m/s and a wind direction of 75^0 from North. The impact of the IFA2 converter station on the trailing winds has been analysed using numerical modelling such as CFD (Computational Fluid Dynamics) analysis. The analysis below shows the impacts of the buildings on wind with ‘worst case’ assumptions using a wind speed of 20m/s and a wind direction of 75^0 from North.

The following CFD analysis is based on a wind velocity of 20m/s. This input represents the meteorological wind speed which is measured at a height of 10m above ground. The CFD analysis model varies the wind speed using the following formulation, where the wind speed U_H at height H above the ground is given by:

$$U_H = U_{met}\left(\frac{\delta_{met}}{H_{met}}\right)^{a_{met}}\left(\frac{H}{\delta}\right)^{a}$$

Where:

a = Exponent in power law wind speed profile for local building terrain;

δ = fully developed strong wind atmospheric boundary layer thickness (m);

a_{met} = Exponent for the meteorological station;

δ_{met} = Atmospheric boundary thickness at the meteorological station (m);

H_{met} = Height at which meteorological wind speed was measured (m);

U_{met} = Hourly meteorological wind speed, measured at height H_{met} (m/s);

Cross-sectional CFD analysis: (direction of flow is right to left)

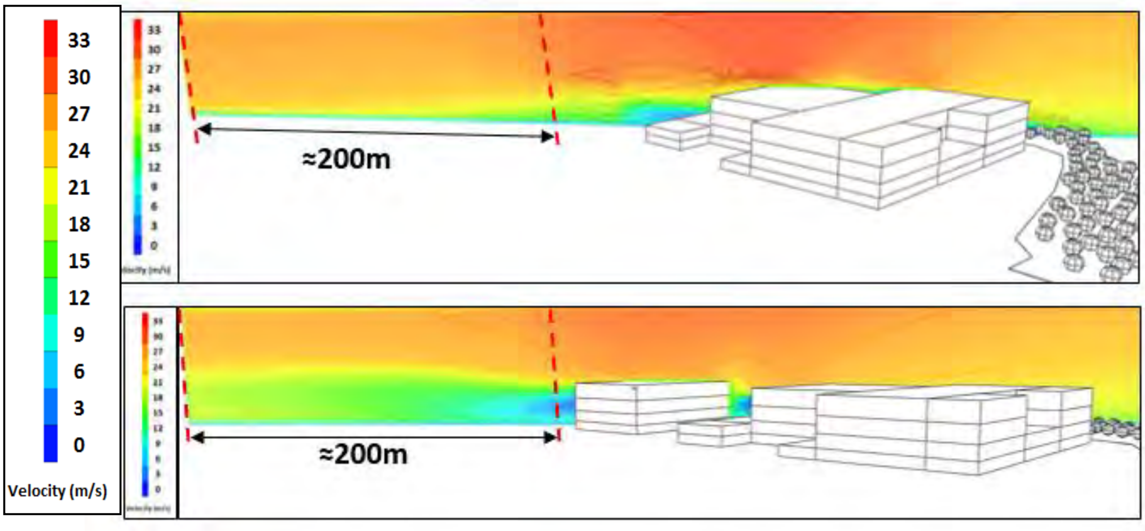


Figure 12 – Velocity Contours (vertical slices)

The vertical slices above (Figure 11) are the outputs of the same CFD simulation taken parallel to the flow direction. The slices are 50 meters apart and both of them show that the wind speed can potentially increase by at least 15% (according to Figure 11) as it reaches the runway due to the shape of the development.

Aerial CFD analysis: (direction of flow is left to right)

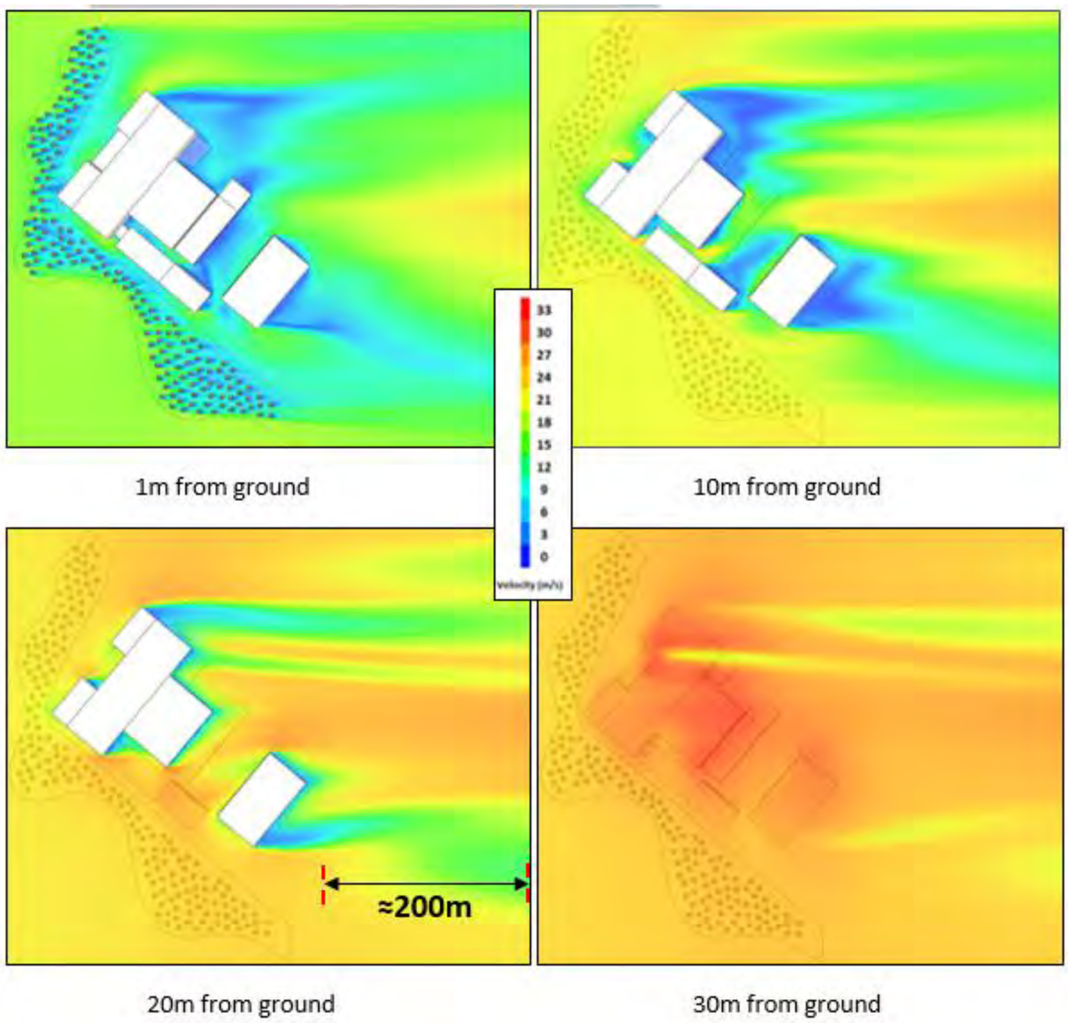


Figure 12 – Velocity Contours (horizontal slices)

The horizontal slices above (Figure 12) show that the wind speed can potentially increase by a worse case of 20% at ground level (1 m) as it reaches the runway due to the shape of the development. If the above simulation was conducted at lesser wind speed that represent typical scenarios, then the pattern would be similar but reduced proportionally.

7.2.4 Conclusion

Preliminary analysis has been carried out for a bounding case, based on pessimistic assumptions in terms of distance from the runway, wind speed and wind angle. A wind speed of 20m/s has been assumed to allow for gusts of wind, with a distance of 200m perpendicular to the disused runway (the main runway being further away at 314m).

The analysis shows that instances of strong winds from the worst case direction is very low. The worst case effect predicted is an increase of 20% at ground level (1m) due to the geometrical shape of the development which indicates an increase in the levels of turbulence. If the simulation is to be conducted at lesser (more realistic) wind speeds, we would expect a similar increase ranging from 15% to 20%.

National Grid are planning additional wind analysis to examine the sensitivity to the parameters and considering wind effects around the main runway. This is raised as a recommendation in Section 9.4.

The impact of the localised wind effects on the aircraft has been considered as part of the FHA in Section 8. Risks are expected to be acceptable as defined in CAP 760 [8] for current airport operations with any localised impacts managed through airmanship and reports to airport management to be included in Notice to Airmen (NOTAMs) if necessary. It is considered however that this should be reviewed for future airport operations.

8 HAZARD IDENTIFICATION RISK ASSESSMENT

International regulations and standards require that any change being introduced that may have an impact on the safety of aerodrome operations or air traffic services (ATS) is subject to a hazard identification and risk assessment / risk mitigation process to support its safe introduction and operation.

For any engineering project, the hazard identification and risk assessment process is an iterative process undertaken in line with the design process. This process commences at the concept stage with preliminary hazard analysis, and develops through the design and implementation phases with more detailed hazard analysis, with any residual risks being identified to be managed in the operational phase. Ultimately, this process demonstrates that hazards are eliminated where practicable, with residual risks acceptable and controlled to a level, which is As Low As Reasonably Practicable (ALARP).

The scope and focus of the hazard identification and risk assessment undertaken at Stage 1 of the IFA2 Interconnector Project (the planning phase), is consistent with the objectives of the scope of work [1], with a qualitative approach taken to the assessment of risks. A systematic approach to the hazard identification and risk assessment process has been undertaken, in the form of an FHA, which covers the Seven Steps for risk assessment in CAP 760 as applicable at this stage in the project.

The FHA is part of a systematic a process to:

- identify ways in which the proposed IFA 2 installation might impair the safety of air traffic operations at Solent Airport (hazards);
- identify how severe such impairment might credibly be;
- estimate the approximate likelihood of such impairment where possible.

The FHA does not explore in depth any new ways of reducing the likelihood or severity of such impairment. The means of managing risk should be identified later in the overall risk management process, however possible ways to manage risks identified during the FHA are recorded in the Hazard Log, which should be used to manage the risks to closure.

The FHA was carried out at a workshop held on the 24th August 2016. The workshop was co-ordinated and facilitated by Arcadis. Technical and other experts from National Grid, Fareham Borough Council, RCAM and Arcadis participated in the workshop to ensure comprehensive coverage and representation from all the specialist areas necessary to identify hazards and assess risks.

Stakeholders (Tenants) did not participate in the workshop; however their views and concerns were sought separately as it was recognised that they could possibly have some bearing on the hazards and risks. This is described in Section 8.2.

8.1 – Functional Hazard Assessment Process

8.1.1 Step 1—Definition of the System

In order to identify all potential hazards, those involved in all stages of the safety assessment must have a good understanding of the proposed change to the existing system, and how it will interact with the aerodrome or Air Traffic System (ATS). The first step in the safety assessment process is therefore to get a clear understanding of the proposed change and the environment in which it will operate.

IFA2 is itself not an aviation system, so it is not appropriate to consider this to be the system for the purpose of the FHA. Instead, the system considered comprised all airport operations, procedures and equipment. Consistent with the scope of work [1], the FHA mainly considered existing airport equipment and operations, but proposed and planned enhancements to the Airport and its services were considered where sufficient detail was available.

The scope of the FHA was agreed by all participants at the outset of the workshop. This considered all aircraft in communication with the Daedalus (control) Tower, or attempting to be in communication with Daedalus Tower. Other aircraft using the Class G airspace in the vicinity of Solent Airport were excluded from the FHA because the effect of buildings under Class G airspace is addressed by compliance with general regulations.

8.1.2 Step 2—Hazard and Consequence Identification

A two-step process was adopted to the hazard and consequence identification:

- A preliminary Hazard Identification and Risk Assessment (HIRA) was undertaken on the 11th August 2016 as a scoping and dry-run hazard identification meeting to prepare for the Main FHA.
- The Main FHA was carried out during the workshop on the 24th August 2016.

8.1.2.1 Preliminary HIRA

The objective of the preliminary HIRA as defined by EUROCONTROL [40] is "to screen out irrelevant issues and ensure an effective preparation for the FHA" to "build a comprehensive check list of items and derive expert's profile".

The HIRA workshop used a set of bow tie risk models produced by the Civil Aviation Authority [38], which are made available for use within the restrictions stated on the CAA website. These models describe the hazards related to aircraft and airport operations and the evolution of the hazard into an accident in some detail. They identify the ways in which hazards can arise, barriers that can reduce the likelihood of the hazards and factors that can reduce the severity of hazards if they do occur. Although these models are based on risks to wide-body commercial air transport, which is not representative of the current traffic at Solent Airport, it was considered that the models included all factors that apply at Solent Airport (as well as many that do not). Thus using these as a basis for the HIRA enabled the team to successfully capture the risks and risk factors at Solent Airport. Additionally, it was recognised that the CAA risk model is established and has been developed over time with input from many experts in the field, hence basing the FHA on this model acts as a check that the assessment is comprehensive.

The attendees at the initial HIRA workshop were:

- Tim Rowe, Arcadis, aviation safety expert and Chairman;
- Martin Van Essen, Arcadis, EMF/RFI expert;
- Iain Coutts, Arcadis, aerodrome safeguarding expert;
- Jane Wilson, Arcadis, safety expert and Project Manager.

The HIRA workshop identified those risk factors that clearly do not apply at Solent Airport or that could not credibly be affected by IFA2, and passed all other risk factors forward to the FHA workshop. It there was any doubt about whether a risk factor was credible or not, it was passed forward to the FHA.

8.1.2.2 Main FHA

At the main FHA workshop, each of the credible risk factors passed forward from the preliminary HIRA workshop were explored systematically, and used the wider expertise of those present at the workshop to assess the plausibility of the risk factor in terms of its contribution to a hazard. Those factors that were considered plausible moved forward to Step 3, i.e. estimation of the severity of the hazard consequences.

The contributory factors and hazards identified at the workshop were recorded in the Hazard Record [48]. The hazards identified were predominantly related to airport operations and the aircraft using the Airport. In accordance with the scope of work however, any foreseeable non-aviation related hazards to staff at the Airport and / or the public were also recorded.

The participants at the main FHA workshop, and those providing input prior to the workshop, were as follows:

- Tim Rowe, TGR Safety Management, aviation safety expert and Chairman;
- Fiona MacKenzie, Fareham Borough Council, Manager Solent Airport Estate
- Dominic Lyster, Fareham Borough Council, urban design & master planning
- Peter Seidenstucker, Fareham Borough Council, historic information
- Martyn Francis, RCAM, Airport Manager
- Jake Stevens, National Grid, HV Cables
- Chris Haswell, National Grid, EMF & EMC
- Lee Fletcher, National Grid, Safety
- Paul Hudson, National Grid, HV Cables Lead
- Valerie Conway, Fareham Borough Council, Advisor Property
- Jane Wilson (Scribe), Arcadis, Safety and Project Manager
- Jason Buckland, Arcadis, Aviation Advisor
- Joseph Senior, National Grid, Converter DE
- Lisa Tippen, Fareham Borough Council, Head of Property
- Onur Ayedemir, National Grid, HV Programme Manager

Those providing input prior to the study were:

- Mike Airey, LSA Electromagnetics, Aerospace EMC
- Martin Van Essen, Arcadis, EMF & RFI

8.1.3 Step 3—Estimation of the Severity of the Hazard Consequences

The main FHA workshop considered each plausible effect of IFA 2, and assessed the severity severity of the associated hazard, and the contribution of IFA 2 to that hazard taking into into account existing controls and mitigations. The severity classification scheme given in CAP given in CAP 760 was used, and is shown in

Table 2. A pessimistic approach was adopted when assigning the severity classification to each hazard.

Accidents	Accident - as defined in Council directive 94/56/EC1 for air traffic services (European Union, 1994). Also includes loss of or substantial damage to major aerodrome facilities. Serious injury or death of multiple staff/members of public at the aerodrome.

Serious Incidents	Serious Incident - as defined in Council directive 94/56/EC1 for air traffic services (European Union, 1994). For the aerodrome, an event where an accident nearly occurs. No safety barriers remaining. The outcome is not under control and could very likely lead to an accident. Damage to major aerodrome facilities. Serious injury to staff/members of public at the aerodrome.
Major Incidents	A major incident associated with the operation of an aircraft, in which safety of the aircraft may have been compromised, having led to a near collision between aircraft, with ground or obstacles. A large reduction in safety margins. The outcome is controllable by use of existing emergency or non-normal procedures and/or emergency equipment. The safety barriers are very few approaching none. Minor injury to occupants of the aircraft or staff/members of public at the aerodrome. Minor damage to aircraft or major aerodrome facilities may occur.
Significant Incidents	Significant incident involving circumstances indicating that an accident, a serious or major incident could have occurred, if the risk had not been managed within safety margins, or if another aircraft had been in the vicinity. A significant reduction in safety margins but several safety barriers remain to prevent an accident. Reduced ability of the flight crew or air traffic control to cope with the increase in workload as a result of the conditions impairing their efficiency. Only on rare occasions can the occurrence develop into an accident. Nuisance to occupants of the aircraft or staff/members of public at the aerodrome.
No Effect Immediately	No immediate effect on safety. No direct or low safety impact. Existing safety barriers come into play to avoid the event turning into a significant incident or accident.

Table 2: CAP 760 Severity Classification

Following the FHA, Arcadis consolidated the results of the workshop to remove duplication and the Hazard Record in [48] was sent to participants for review, comment and agreement.

The hazards identified are recorded on the Hazard Log forms in [48], using the template in CAP 760 [8]. The Hazard Log is used to manage risks through a project lifecycle, hence at this stage in the safety management process the hazard records are not fully completed; further details should be added as the design, and hence risk control measures, evolves. The FHA workshop also identified a number of possible contributing factors to hazards. These are also recorded in the hazard record sheets [48], and their relationship to the identified hazards (or an explanation where they do not relate to identified hazards) is given in [48].

As stated above, the hazard log forms in [48] relate to the IFA 2 Project and should be used by National Grid and Fareham Borough Council to manage the hazards and risks to closure as the detailed design evolves. It is distinct from the existing Solent Airport risk register [33]; although the Airport might at project completion, wish to incorporate the residual risks from the hazard log forms that require ongoing management in operations, within its existing risk register.

8.1.4 Further FHA Steps

The remaining steps (4 to 7) of the CAP 760 process relate to the future risk management process in line with the evolution of the design and the development of design and operational control measures, as follows:

- Step 4 - Estimation/assessment of the likelihood of the hazard consequences occurring. It was agreed at the workshop that the likelihood of the hazard would need to be assigned when the design and hence the control measures is at a more advanced stage. However, it was noted that the highest consequence assigned is significant which, based on the CAP 760 risk matrix, would require the likelihood of the hazard consequences to occur in excess of ten times per year before the risk would be “Unacceptable”.
- Step 5 - Evaluation of the risk. As stated above, at this stage only an indication of the risk can be given by the Severity (see Steps 3 and 4). As the design evolves and the risk management process progresses, risks may be evaluated using the risk matrix in CAP 760.
- Step 6 - Risk mitigation and safety requirements. At this stage, only potential measures to mitigate risks were identified at the workshop. Some actions and recommendations are identified to progress these measures as the design evolves.
- Step 7 - Claims, arguments and evidence that the safety requirements have been met and documenting this in a safety case. This step should be achieved at the end of the detailed design stage and before implementation.

8.2 Input from Stakeholders

Stakeholders have been consulted throughout the consultation process, led by Fareham Borough Council. For the purpose of this study, it was decided that input from stakeholders would be through Fareham Borough Council and RCAM who directly participated in the study. In addition to this, the stakeholders were advised that the study was taking place and given the opportunity to express their views via email.

Three Stakeholders responded to this (Britten Norman, the Maritime Coastguard Agency and Gosport Borough Council) and their views are summarised in Appendix A, along with an assessment of whether this is a safety concern relevant to this study or not.

Review of the issues raised confirms that all relevant safety concerns raised by stakeholders has already been considered within the FHA. In the case of Britten Norman issues raised, additional assessment is underway to address their specific concerns related to more complex aviation systems. These are expected to address the issues being raised.

9 CONCLUSIONS

Overall, from the information available at this time, it is concluded that the risks posed by IFA2 are not expected to adversely impact the Airport's current operations and any hazards are expected to be straightforward to manage. Conclusions from each of the tasks are summarised below.

9.1 Aerodrome Safeguarding

The IFA2 converter station has been assessed against aerodrome safeguarding criteria. The aim has been to ensure that the proposals do not currently impact on the safe and efficient operation of the Airport and as far as is practical, ensure that future developments on the Airport itself will not be impacted by the proposals.

The assessment analysed the new buildings against the OLS. The buildings are situated within the Transitional Surface and the Inner Horizontal Surface but at a maximum of 22 m in height, the buildings will not create an infringement.

Overall, the plans for the IFA2 converter station will not conflict with aerodrome safeguarding criteria. There are a few minor issues to consider when developing the final plans but the general principle of the development to date is considered to be acceptable and will not adversely impact on the operations of the Airport.

A flat or low-pitched roof on the converter station could attract birds. The site is within the Airport and will be well managed, there is a good relationship between the Airport and surrounding operators so the measures outlined in the report will be sufficient to control risks. However, this is recorded as an action in the Hazard Log for the management of the converter station.

Lighting at the converter station should follow the Airport Operators Association advice to ensure that the operation of the airfield is not adversely impacted.

The above actions were identified through the hazard identification and risk assessment and are recorded in the hazard log for ongoing management.

The use of cranes during construction is a temporary measure but the type of crane used should be considered and agreed with the Airport at the earliest opportunity, particularly as the site is in such close proximity to the runway.

9.2 Technical Assessment EMF/RFI

The assessment of EMF and RFI effects is undertaken at the planning stage when the details of the design of the converter station are not finalised in design specification. Hence it is based on a number of assumptions, consistent with the preliminary assessment in [3] which are considered to be reasonable, but will need to be validated as the design progresses.

The assessment concludes that within the scope of this study (i.e. impact on existing airport operations) the risks from EMF and RFI effects is expected to be acceptable as defined by CAP 760 [8]. All actions relating to mitigation measures identified to ensure risks are acceptable are recorded in the Hazard Log to be managed and tracked to closure over the project lifecycle.

Analysis undertaken so far has focussed on the existing airport operations and in particular the safety systems. Recommendations are given to develop the analysis as the design progresses in order to provide a robust safety and technical justification for EMF and RFI effects and confirm that risks are acceptable as defined in CAP 760 [8]. Additionally, the assessment has taken into consideration future plans for the Airport and the surrounding area where they are known, with recommendations for further assessment work in the future.

9.3 Wind Effects

The assessment of wind effects has peer reviewed the previous assessment in Reference [2] and undertaken some independent analysis to confirm that any impact on wind is small.

The preliminary analysis has been carried out for a bounding case, based on pessimistic assumptions in terms of distance from the runway, wind speed and wind angle. A wind speed of 20m/s has been assumed to allow for gusts of wind, with a distance of 200m perpendicular to the disused runway (the main runway being further away at 314m).

The analysis shows that instances of strong winds from the worst case direction is very low. The worst case effect predicted is an increase of 20% at ground level (1m) due to the geometrical shape of the development which indicates an increase in the levels of turbulence. If the simulation is to be conducted at lesser (more realistic) wind speeds, we would expect a similar increase ranging from 15% to 20%.

National Grid are planning additional wind analysis to examine the sensitivity to the parameters and considering wind effects around the main runway. This is raised as a recommendation in Section 9.4.

The impact of the localised wind effects on the aircraft has been considered as part of the FHA in Section 8. Risks are expected to be acceptable as defined in CAP 760 [8] for current airport operations with any localised impacts managed through airmanship and reports to airport management to be included in Notice to Airmen (NOTAMs) if necessary. It is considered however that this should be reviewed for future airport operations.

9.4 Hazard Identification and Risk Assessment

The Hazard Identification and Risk Assessment identified 23 hazards and 32 contributory factors. Contributory factors, whilst not being a hazard in themselves, are recorded as they could potentially be a causal factor to a hazard, or adversely impact the mitigation of a hazard that prevents a hazard escalating into an accident. Hazards were ranked in terms of severity in accordance with the risk-ranking scheme in CAP 760. In most cases, no likelihood category could be assigned at this stage as the design and hence the control measures are not sufficiently developed. The hazard log in [48] should be used to progress and manage the hazards through to closure.

Of the 17 hazards considered, most were agreed to have no immediate or no impact. The hazards below were assigned a severity of “Significant”, based on the CAP 760 [8] criteria. In the case of these hazards, whilst there are a number of barriers preventing an accident occurring, they could potentially result in a reduction in safety margins if not managed, but with a number of barriers to prevent an accident occurring. These hazards should be reviewed as the design and the future plans progress:

- wind impact (e.g. turbulence). Wind effects due to the converter station are expected to be limited. Any change in the wind patterns can be managed for existing airport traffic by familiarisation, awareness and generally good airmanship, further assessment may be required to confirm this for future aircraft;
- bird strike, a flat or low-pitched roof could attract birds. A bird management strategy needs to be in place and consideration needs to be given to future landscaping and the choice of trees. The building design needs to provide access to the roof for bird management;
- distraction of aircrew caused by reflection (glare) from building structure and cladding. Building external surfaces should be designed not to present a distraction to aircrew through reflection / glare e.g. in strong sunlight. Fareham Borough Council should also consider placing conditions on the use of the land to require no services likely to cause reflections / glare distracting to aircraft

Other actions that were identified within the FHA [48] to ensure that risks are ALARP are as follows:

- a number of hazards raised the need to incorporate safeguards into the design specifications. These specific safeguards are stated in the hazard log [48].
- at the moment there are no UAVs (e.g. drones) flying at Solent Airport. A review of the RFI impact on UAVs is needed if there are any future plans to allow these to fly. It is understood that this is a possibility; hence this should be considered as part of future work. It is likely that any risks to or from UAVs may be controlled by defining the areas where UAVs are permitted to fly.
- localised areas where magnetic fields could cause compass deviations when taxying have been indicated by the preliminary assessments, these need to be confirmed.
- localised areas where magnetic fields could lead to incorrect calibration of magnetic compass need to be identified, and instructions not to calibrate in those areas promulgated.
- a tree growth management strategy will need to be in place. It is expected that this will be managed through the planning process.

The Hazard Log in [48] should be used by National Grid and / or Fareham Borough Council to manage and track the hazards and risks through to closure over the duration of the project lifecycle. On completion of the project, any residual risks that require ongoing management through operational procedures and measures should be transferred to the any hazard logs that Fareham Borough Council may have as Landowner and the Solent Airport hazard register.

Table 3 below captures the recommendations and main actions raised from the assessment which need to be managed to closure as the project progresses.

Recommendations raised by the Technical Assessment	
R1	The Hazard Log should be used by National Grid and / or Fareham Borough Council to manage and track the hazards and risks through to closure over the duration of the project lifecycle. On completion of the project, any residual risks that require ongoing management through operational procedures and measures should be transferred to any hazard logs that Fareham Borough Council may have as Landowner and the Solent Airport hazard register.
R2	A bird management strategy needs to be in place and consideration needs to be given to future landscaping and the choice of trees. The building design needs to provide access to the roof for bird management.
R3	Regular pruning should be undertaken on surrounding vegetation if it is considered a risk to a potential infringement of the Obstacle Limiting Surface
R4	Lighting at the converter station should follow the Airport Operators Association advice to ensure that the operation of the airfield is not adversely impacted at night. Currently night time flying is not permitted, however this is a possibility in the future.
R5	Wind effects due to the converter station are expected to be limited with any change in the wind patterns easily managed for existing airport traffic through familiarisation, awareness and generally good airmanship. Consideration should be given to revisiting this in line with plans for any future aircraft types using the airport.
R6	Preliminary wind effects analysis is completed for a pessimistic bounding case. National Grid is planning additional analysis to examine the sensitivity of the wind effects to various parameters around the main runway.
R7	Distraction of aircrew caused by reflection from the building structure and cladding (glare). The buildings should be designed not to present a distraction to aircrew. The buildings should have non-reflective cladding. Fareham Borough Council should also consider placing conditions on the use of the land to require no services likely to cause reflections / glare distracting to aircraft.
R8	The analysis on RFI so far has focussed on safety related systems. Consideration should also be given to potential interference to other objects and systems, e.g. businesses, mobile phones, etc. which should comply with IEC 61000 standards.

R9	It is recommended that Fareham Borough Council consider any EMC sensitivity parameters for future tenants and businesses using the airfield (not already identified) who may be engaged in activities such as meteorology, calibration, precision-fabrication and production, scanning, etc. in order that these can be objectively assessed with National Grid. Where the potential for impact exists, consideration should be given to where they are located i.e. distance from the converter station as necessary.
R10	Analysis of potential interference with digital television signals has considered the effects of the physical 'shadow' of the converter station. It is expected that any effects of interference by the converter station will be limited; however, it is recommended that a future assessment confirms this by considering variations in the signal strength of the digital television signal and whether this can be disturbed or suppressed by the emissions of the converter station.
R11	The assessment of magnetic fields is sensitive to design parameters assumed e.g. cable design and cable type, hence it is recommended that these calculations be re-confirmed and, if necessary, developed further as the design and future plans progress.
R12	It is recommended that future assessments consider power frequency induced voltages and potential-to-earth effects as the detail design of the converter station and cables progresses to rule out any risks. This should also confirm that there are no other 50 Hz sources that could potentially cause inductive effects.
R13	The use of cranes during construction is a temporary measure but the type of crane used should be considered and agreed with the Airport at the earliest opportunity, particularly as the site is in such close proximity to the runway.
The following actions from the FHA are recorded in the Hazard Log. They should be progressed and managed to ensure that risks are reduced to As Low as Reasonably Practicable (ALARP).	
A1	a number of hazards raised the need to incorporate safeguards into the design specifications. These specific safeguards are stated in the hazard log [48].
A2	at the moment there are no UAVs (e.g. drones) flying at Solent Airport. A review of the RFI impact on UAVs is needed if there are any future plans to allow these to fly. It is understood that this is a possibility; hence this should be considered as part of future work. It is likely that any risks to or from UAVs may be controlled by defining the areas where UAVs are permitted to fly.
A3	localised areas where magnetic fields could cause compass deviations when taxying have been indicated by the preliminary assessments, these need to be confirmed.
A4	localised areas where magnetic fields could lead to incorrect calibration of magnetic compass need to be identified, and instructions not to calibrate in those areas promulgated.

A5	a tree growth management strategy will need to be in place. It is expected that this will be managed through the planning process.

Table 3 – Recommendations and Main Actions

APPENDIX A

Stakeholder Views

Concern	Means of addressing Concern
The risk of aircraft damage and potential crash causing serious injury or loss of life to the operating crew and third parties from foreign objects (FOD) left unsecured during working silent hours.	This is a concern over the management of the construction process and the risk of foreign objects being left by construction workers. Hazards during the construction process are not part of this assessment. These will need to be managed through the safety management arrangements of the future construction contractor.
The risk to the safe recovery of the aircraft due to the non- availability of the runway due to incursions, leading to the potential for serious injury or loss of life to the operating crew and/or third parties.	This is understood to be a concern over exposed HV cables and live electricity following an aircraft crash leading to delay to recovery. Cable damage / insulation failure was considered within the FHA. Protection systems would cause an auto-trip and isolate the electrical supplies.
The risk of increased traffic affecting shift teams from the Maritime Coastguard Agency to be held up and the potential for delayed response.	This is a concern over construction traffic and possibly increased traffic at the Airport created by future planned developments, resulting in delay to the MCA response. National Grid has confirmed that assessments have shown that the increase in construction traffic will not be significant. This is a temporary construction issue, outside the remit of this assessment that will be managed through a construction management plan.
The risk of Electromagnetic Interference/ Radio Frequency Interference leading to the temporary or permanent grounding of the aircraft.	The risk of RFI has been considered in this assessment and assessed at the HIRA. Risks due to RFI are assessed as low.
Concern over visual impact on landscape (scale, height etc.)	This is an environmental concern and is being addressed through the planning considerations.
Concern over noise generated and disturbance to users of the open space.	This is an environmental concern and is being addressed through the planning considerations.
Concern over EMF emissions and the impact on operations.	The risk of EMF emissions has been considered in this assessment and assessed at the FHA. Risks due to EMF are assessed as low, with only a localised impact on the ground. Measures to manage the localised impact were proposed at the HIRA.
Alternative Sites: Fareham Borough Council must be fully satisfied that there are no suitable alternative sites available, or to justify the encroachment into and visual erosion of the Strategic Gap.	This is an environmental / planning policy consideration and is being addressed through the planning considerations.

Concern	Means of addressing Concern
Concern over emissions from underground HV cables.	The risk of EMF emissions has been considered in this assessment and assessed at the FHA. Risks due to EMF are assessed as low, with only a localised impact on the ground. Measures to manage the localised impact were proposed at the HIRA.
Concern over risks to aviation equipment (navigation and communication).	The risk of RFI has been considered in the assessment and assessed at the FHA. Risks due to RFI upon aviation equipment are assessed as low.
Risks to customer (Britten Norman) specific equipment – effects from RFI and magnetic fields on more complex aviation equipment.	Britten Norman concerns were considered at the FHA and are being addressed as a specific concern by National Grid.
Impact on the compass base area and CAP 562 prohibits the co-location of compass bases with EMF emissions.	There is no compass base at Solent Airport currently. Localised impacts on compass calibration from EMF emissions was considered in the FHA as a contributory factor. This may need to be considered for future airport developments.
Need for a monitoring regime for EMF emissions.	This is a consideration for the planning process.
Disruption caused by construction.	This is a consideration for the planning process.

APPENDIX B

Occupiers at Solent Airport

Existing and future occupiers of airside facilities at Solent Airport, based on current plans include:

- Maritime and Coastguard Agency (MCA) - helicopter movements and training;
- Aerotech Solent – aircraft maintenance company;
- Atlas Helicopters – no longer occupy a hangar, run tours from the tower;
- Bournemouth Avionics – long term tenant of new business hangars;
- Britten Norman – long term tenant and largest aviation occupier;
- Hampshire Aeroplane Club – long term tenant;
- Lee Bees Model Aircraft Flying Club – occasional user;
- Lee Flying Association – long term tenant, storage of aircraft;
- Nason Energy – prospective developer;
- Phoenix Aviation – located in the tower a long term flying club;
- Portsmouth Naval Gliding Club – currently located on the western side, negotiating to move into new general aviation complex area;
- Solent Microlights – general aviation complex;
- Deltair – aircraft maintenance company – will occupy new hangars long term;
- Malcom Paul – occupies hangars – storage of planes;
- Tiger Motorcycle Display Team, a local community group not a tenant, but uses various locations.
- TUV – testing GPS – occasional use of airport – (testing masts);
- NATS – have a planning application in place for a radar tower, this is a training facility but will need approval by CAA;
- MAST - tenants in tower building (office space only).

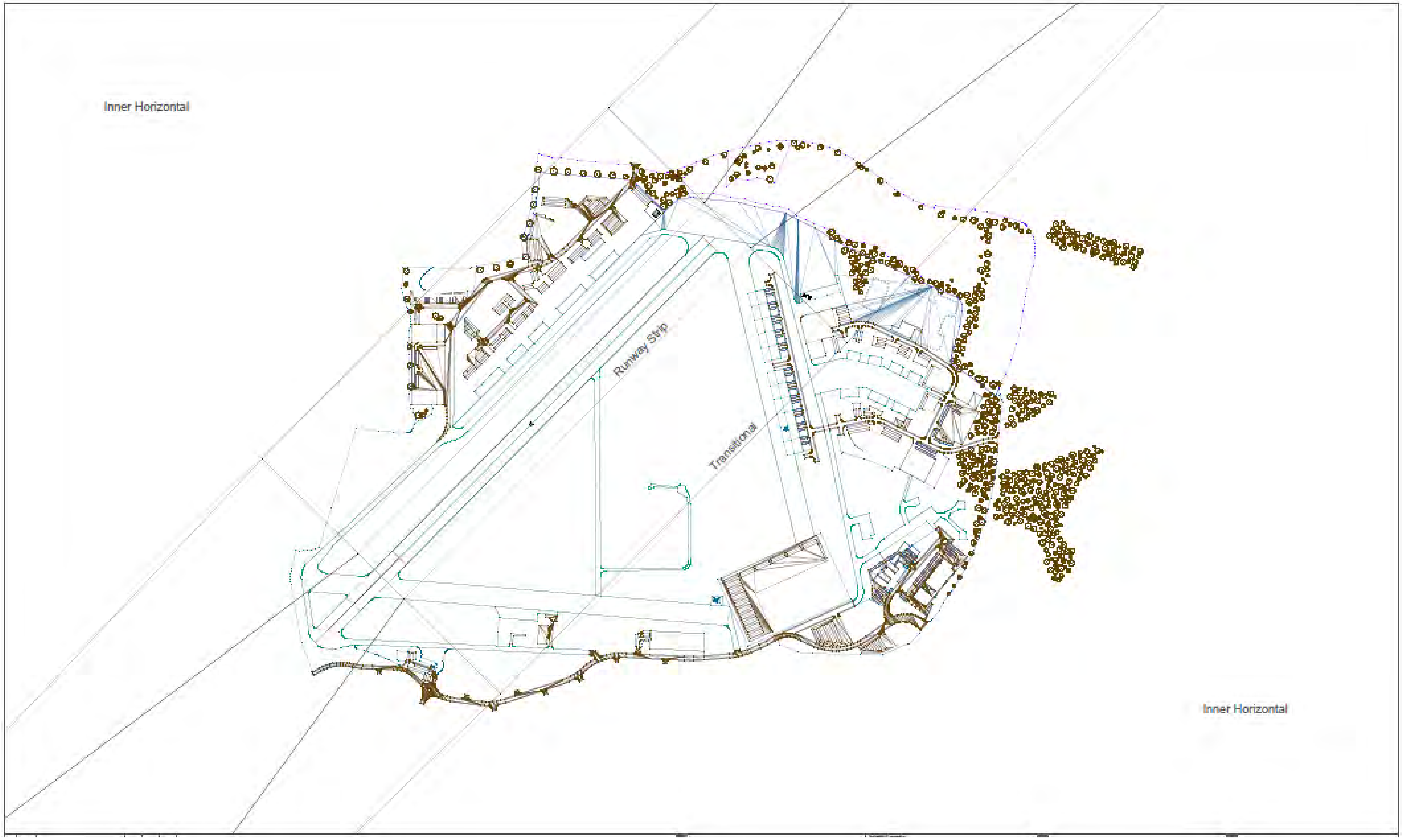
APPENDIX C

Figures from Safeguarding Assessment (Section 6)

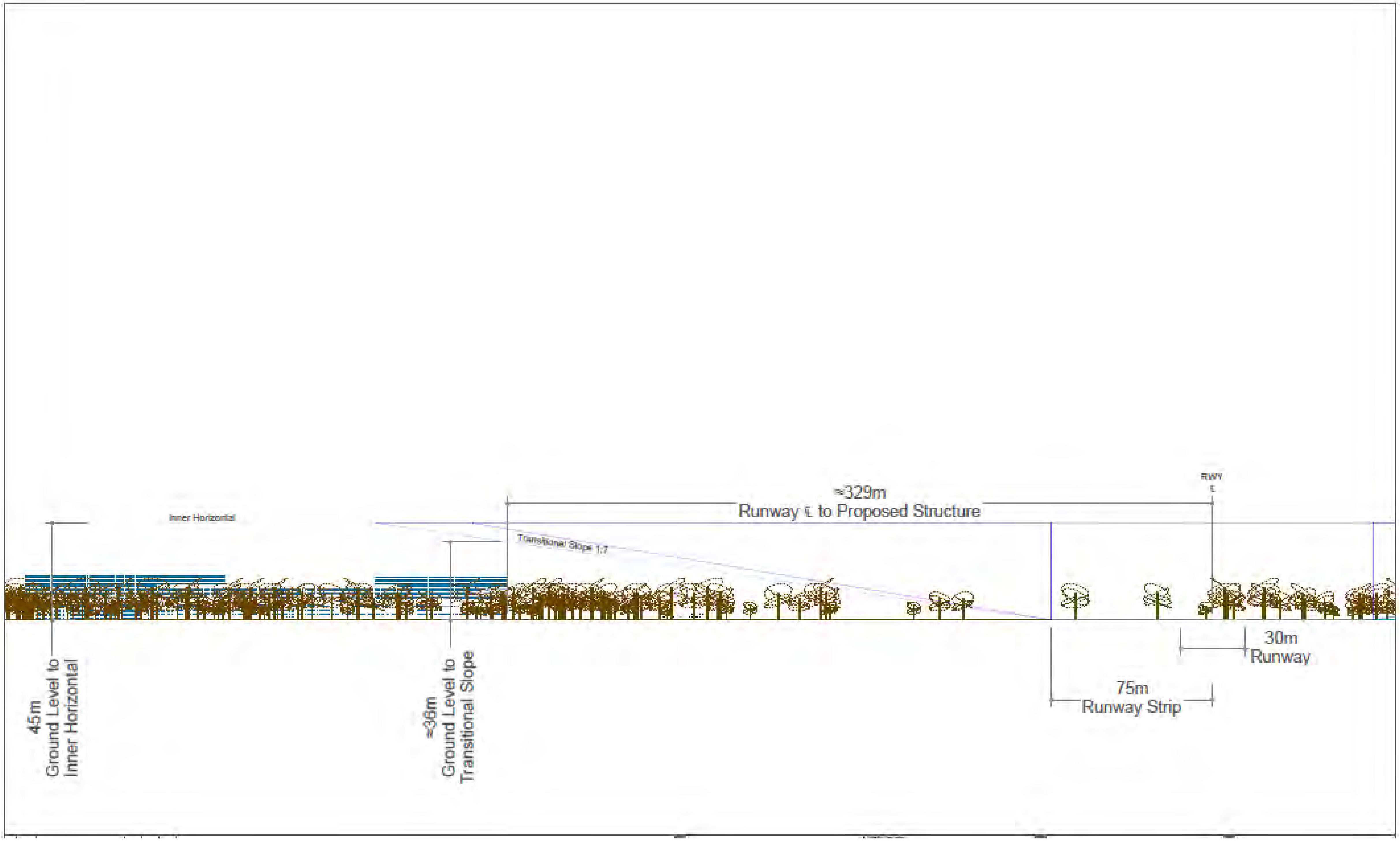
Position of Buildings in relation to Airport and OLS (Figure 2)

Position of Buildings in relation to OLS with background image (Figure 3)

Position of Buildings in relation to OLS without background image (Figure 4)

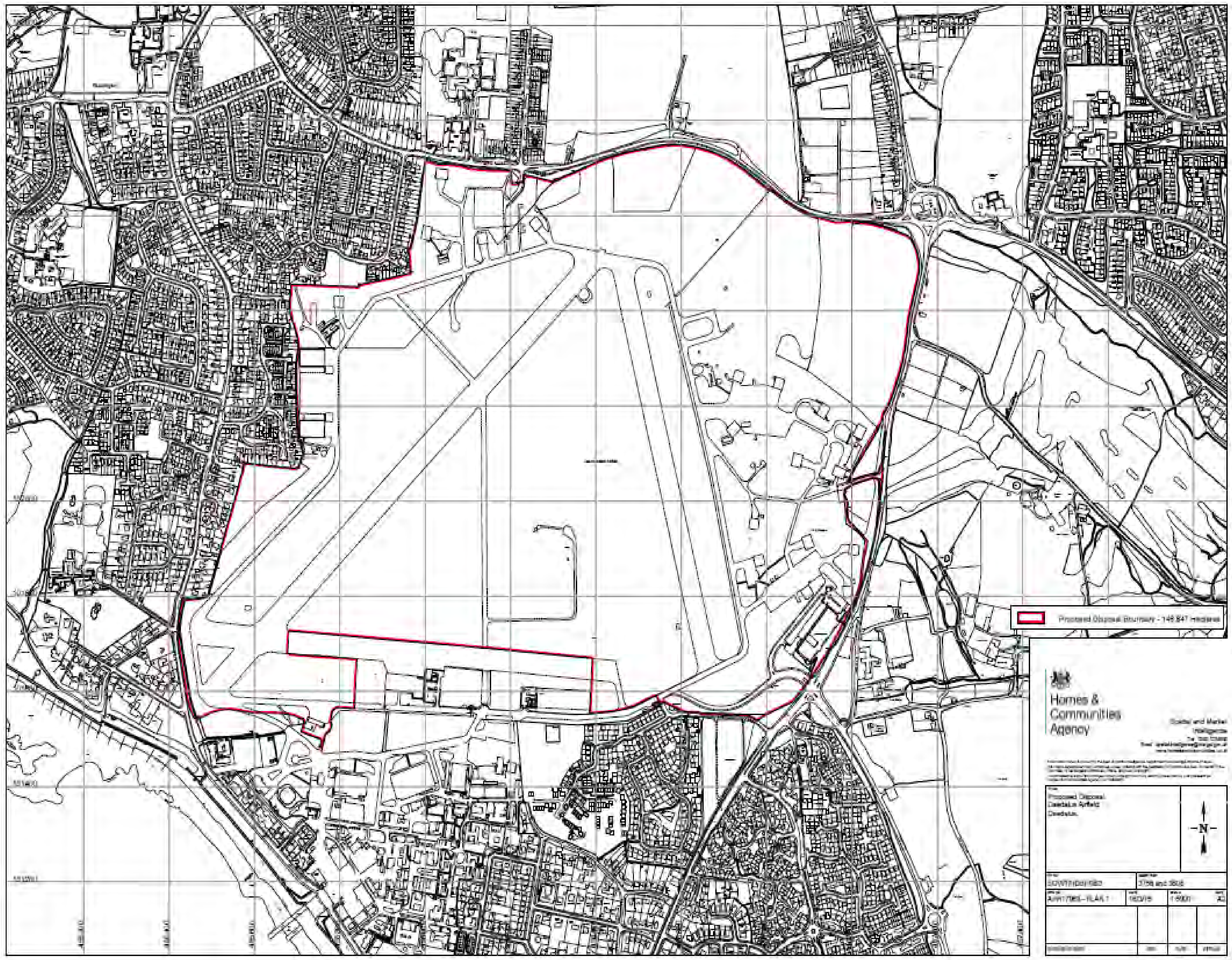


Location of the Converter Station in relation to the relevant OLS (Figure 6)



APPENDIX D

Solent Airport and Surrounding Area showing the Converter Station Site



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