APPENDIX A1

ARCADIS Design & Consultancy for natural and built assets

SAFETY JUSTIFICATION REPORT

for the IFA2 Interconnector on the Solent Airport, Daedalus

35588103/RP/080917/3

NOVEMBER 2017

Incorporating

EC HARRIS BUILT ASSET CONSULTANCY

Hyder

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VERSION CONTROL

Issue	Revision No.	Date Issued	Description of Revision: Page No.	Description of Revision: Comment	Reviewed By:
1	1	08/09/2017	Draft Report issued for comment.		S Scannali T Rowe
	2	06/10/2017	Incorporating comments from National Grid and Fareham Borough Council	Addressing various comments on Rev 1	S Scannali
	3	10/11/2017	Section 9.3.1 includes findings from cable trials. Also updated following hazard review and comments	Incorporates Findings on cable trials, update on hazard review and addresses comments from FBC on Rev 2	S Scannali

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EXECUTIVE SUMMARY

National Grid Interconnector Holdings (NG) is in the process of developing and implementing a new electricity interconnector facility, the Interconnexion France-Angleterre 2 (IFA 2). The facility is being developed jointly with Réseau de Transport d'Electricité (RTE), the French transmission system owner and operator. It will link the United Kingdom's electricity transmission network with France's, and will enhance the security, affordability, and sustainability of energy supply to both countries.

The facility consists of two converter stations, one sited in each country. The UK converter station is to be sited to the north-east of Solent Airport at Daedalus ("Solent Airport"). National Grid proposes to route high-voltage direct current and high-voltage alternating current cables in a shared cable corridor to the west and north of the Solent Airport main runway.

During the planning application and land acquisition processes, NG, together with Fareham Borough Council (FBC) and Regional and City Airports Management (RCAM); the airport operator, commissioned a number of assessments as part of best practice development and design to determine whether the siting of the converter station and proposed routing of cables at Solent Airport could affect the airport's existing operations. This work included both technical and environmental assessment to examine effects focussed around the main potential hazards, which are:

- Hazards related to aerodrome safeguarding as identified in CAP 738 [1], these include any potential impacts on airport operations from obstacle limitation surfaces, building lighting, and bird hazard management.
- Electromagnetic field (EMF) and radio-frequency interference (RFI) emissions from the converter station, the equipment and HV cables with potential impact on airport and aircraft operation.
- Wind flow effects caused by the IFA 2 building and potential safety impact on flying operations.

This work was also intended to help address stakeholder concerns about the proposals to site the converter station at Solent Airport, and has provided supporting information to the public consultation and planning application processes.

Over 2016 and 2017, further, more detailed technical assessment has been undertaken; this work has progressively developed the initial body of evidence. As part of this work, Arcadis was commissioned to undertake independent peer review of the body of evidence as well as further technical assessment of the converter station to assess whether the IFA2 facility can co-exist safely with the existing airport and its operations. This work, presented in [2], [3] and [6] includes a hazard identification and risk assessment study, and as a result of this a Hazard Log has been developed in accordance with the standard CAP 760 [4].

The project is now progressing through the detailed design process and some initial trials have been completed. This document provides an interim safety justification for the IFA2 facility at Solent Airport, and is intended to support the application to the FBC Executive Committee as planning authority for the full planning acceptance and consent to progress to the next stage in the Project. As for any major project, the full safety justification will be complete post construction, when all the validation evidence from testing and commissioning is available.

A safety justification is a documented body of evidence that provides a demonstrable and valid argument that a system is adequately safe for a given application and environment over its lifetime. This safety justification considers only IFA 2 at Solent Airport. It does not consider other hazards to the airport or provide a safety case for the airport itself. The information in this safety justification may be used by RCAM as Airport Operator to update the airport safety management system [11] and to support a submission to the Civil Aviation Authority (CAA) under CAP 791 [5] which is the process to notify the CAA of changes at an aerodrome, covering both the infrastructure and management system changes related to the introduction of IFA 2.

This safety justification document is supported by two addenda. Addendum 1 presents the current hazard log which details the status of the hazards and the assurance evidence at this point in time. Addendum 2 provides additional analysis and assessment to address some specific hazards in the hazard log and forms part of the assurance evidence referenced within the hazard log, and includes:

- A revised assessment of airfield safeguarding taking account of the IFA 2 design and updating the assessment in [2].
- additional wind flow analysis carried out to supplement that in [2], [3] and [6]. This models interaction effects between the IFA2 converter station and the Faraday Business Park.
- Further independent peer review of some additional documents related to Radio Frequency Interference (RFI) and Electromagnetic Field [EMF] and consideration of EMF / RFI effects. This confirms some assumptions made in the assessments in [2] and [3] and considers some specific hazards within the hazard log that were not explicitly or fully covered by the body of evidence available.
- Consideration of some Maritime & Coastguard Agency (MCA) equipment in the context of effects related to IFA 2,
- Additional assessment of potential future options that may be available to improve the navigation environment (including an instrument landing capability). This considers any potential impacts related to the IFA 2 facility as well as general considerations that will need to be progressed by the airport operator should there be a decision to introduce such equipment at Solent Airport in the future.
- Assessment of Unmanned Aerial Vehicles (UAVs), considering any potential impacts related to the IFA 2 facility as well as general considerations that will need to be progressed by the airport operator.

Some of the key safety requirements and objectives for the IFA 2 facility are formalised as constraints through planning conditions and the legal covenants in the Converter Station Lease, and formal agreement of these conditions is a vital part of the assurance evidence.

At this stage in the project (part way through the detailed design process), the body of evidence which forms the safety justification for IFA 2 is progressively evolving. As for any major project, the assurance evidence will continue to develop over the project lifecycle. Consistent with the stage in the project lifecycle, a robust base of analysis, calculations and assessment exists which establishes a high level of confidence that safety objectives and safety requirements will be met and that risks related to IFA 2 are acceptable as defined in the CAA guidelines CAP 760 [4]. Initial testing has been completed simulating the maximum electromagnetic fields that would be generated by the HV DC and AC cables. This has successfully demonstrated the accuracy of the calculations used to generate the EMF analysis and gives confidence that the requirements of planning condition 48 (concerning EMF emissions) will be met. The testing has also validated predictions that effects on aircraft systems are negligible.

The focus of the assurance evidence from this point will be the issue of the detailed design and the extensive programme of testing planned to validate the computer analysis and calculations and ultimately to provide the demonstration of compliance with planning conditions and requirements from legal agreements.

The main conclusions of the safety justification at this stage are as follows:

- Overall, the current state of the evidence available provides a high level of confidence that potential safety risks posed by IFA2 should not adversely impact the airport's current operations or the known planned developments. Once all the dependencies stated in this report are complete, the demonstration that risks posed by IFA2 are acceptable and ALARP as defined in CAP 760 [4] will be complete.
- There are no hazards, risks or issues identified which may place unreasonable or impractical constraints on the design of the IFA 2 Facility.
- The body of assurance evidence available and planned is thorough and diverse, including analysis, calculations and assessment, testing, and simulation. Once complete the extent of the evidence will exceed the minimum requirements in CAP 760 [4] for the confidence level required for validation evidence, based on risk.
- The actions to establish the remaining assurance and thus to complete the body of evidence are recorded in the Hazard Log and captured as "dependencies" in this safety justification.

REFERENCES

Ref No	Reference Identifier	Title
1	CAP 738 Version 2	Safeguarding of Aerodromes
2	35588100/NT/300916/1	Technical Assessment (Main Report) of the possible impact of the IFA2 Interconnector at Solent Airport Daedalus.
3	35588102/RP/270617	Technical Assessment (Main Report) of the possible impact of the IFA2 Interconnector at Solent Airport Daedalus.
4	CAP 760 Version 1	Civil Aviation Procedure (CAP 760) Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases.
5	CAP 791 Version 2	Notification of Changes to Aerodrome Infrastructure
6	35588100/NT/300916-3 - Addendum 1	Technical assessment Wind Flow Analysis
7		Draft Daedalus Masterplan – 12 October 2016
8	35588100/NT/300916/2	Technical Assessment (Hazard Log) of the possible impact of the IFA2 Interconnector at Solent Airport Daedalus.
9	35588102/RP/080517	HAZARD LOG REPORT Technical Assessment of the Effects of IFA2 interconnector at Solent Airport
10		Daedalus: A Vision and Outline Strategy
11	CIMS/RCA/DA/GT11.0 & 12.0	RCAM Daedalus SMS Incorporating the Aerodrome Manual.
12	LSAEM/2015/019/TR/01	RFI Assessment Report for IFA2 and Daedalus Airfield - LSA Electromagnetics Report.
13		National Grid – Compass Deviation Calculator for DC cable 270716 and magnetic field calculations
14		Verification of calculations of deviations to magnetic compasses from HVDC cables.
15	LSAEM/2015/019/TR/01- Issue 2	RFI Assessment Report for IFA2 and Daedalus Airfield - LSA Electromagnetics Report. - Addition of Annex 1 with summary of airfield systems - Addition of RTCA/D)160 radiated emission analysis for aircraft radios – Addition of notes on general RFI
16	LSAEM/2015/019/TR/002 Issue 1	Aircraft Magnetic Field Susceptibility Assessment Report for IFA2 – LSA Electromagnetics Assessment of magnetic field effects on aircraft
17	AR/NG/17102016 Issue 1	Islander and Defender Magnetic Field Susceptibility Assessment Report for IFA2 Aviation Requirements Assessment of magnetic field effects on Islander and Defender aircraft
18	QINETIQ/MS/AD/LR1604249/1	Magnetic effect -impact on UK MoD Islander and Defender Aircraft QinetiQ Assessment of magnetic field effects on Islander and Defender aircraft

Ref No	Reference Identifier	Title
19	QINETIQ/MS/AD/LET1604895/1	Magnetic effect -impact on UK MoD Islander and Defender Aircraft Assessment QinetiQ Calibration opinion 23 November 2016
20	OVE-IFA2-REP-001 Issue 1	National Grid, IFA2 Converter TV and Radio Reception Study Issue 1 | 14 September 2016
21	OVE-IFA2-REP-001 Issue 2	National Grid, IFA2 Converter TV and Radio Reception Study Issue 2 | 27 June 2017
22	LSAEM/2015/019/TR/005	RF Survey Test Report for the IFA2 Development at Solent Airport. March 2017.
23	239216-02 Issue 2 May 2016	National Grid Interconnector IFA2 - Assessment of Possible Wind Effects on Flying Operations of HMS Daedalus – Ove Arup Report.
24	CIGRE TB391	Guide for measurement of radio frequency interference from HV and MV substations.
25	1JNL575900 (Draft)	Audible Noise - Assessment for Planning Application
26	75936551 Issue 1	TUV-SUD document for FBC - IFA2 Interconnector Project – Review of EMC / EMF Assessment Reports.
27	IDE 00034 version P3	IFA2 Converter Station External Flood Lighting (for FBC approval)
28	IKA-0508 version P3	Converter Station Reactor Hall 5 Degree Pitch Option Elevations
29	1JNL439067, C	Fire Systems Description
30	500-001 Revision B	AGL Duct Installation Arrangement and Detail
31	PPL15142-SE-RA-001-v00	Preliminary impressed voltage assessment for cables at Daedalus
32	BS 5489 -1:2013	'Code of Practice for the Design of Road Lighting
33	AOA Advice Note 2	Safeguarding of Aerodromes
34	International Commission on Non-Ionizing Radiation Protection	ICNRP guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 ghz)
35	1JNL568775 Rev C	Radio and Telecomms Interference and EMF assessment, ABB
36	1JNL549328 Dated 27-5-16	Potential New Solution with Layout Rotation in Daedalus
37	FM-5267	3D Masterplan 2017 update
38	G3221.181I	Drawing: IFA2 Overview Map Daedalus New Boundary, NG
39	35588103/RP/260917 (Draft)	Wind Flow Analysis for the IFA2 Facility
40	RWDI #1703422 (Draft)	Airport Runway Wind Study
41	1JNL553364 Rev A	HF Performance Report
42	1JNL590610 (2017-10-09)	Preliminary assessment for touch and step voltage
43	GTech Surveys Limited 2017 09/10/2017	Pre-Construction 2G, 3G and 4G Mobile Telephone Network Signal Survey IFA2
44	GTech Surveys Limited 2017 03/10/2017	Pre-construction Airwave Radio Network / TETRA Signal Survey

Ref No	Reference Identifier	Title
45	IFA2-IJV-CAB-TTR-0003 (Nov 17)	Technical Note: Tests to Verify Ability to Comply with Planning Conditions on Electric and Magnetic Fields for IFA2 Cables at Daedalus Airfield
46	IFA2-IJV-CAB-TTR-0004 (Nov 17)	Technical Note: Tests of Aircraft in Electric and Magnetic Fields from IFA2 Cables at Daedalus Airfield.

TERMS AND DEFINITIONS

Term / Abbreviation	Definition
Airport	Solent Airport at Daedalus
AAIB	Air Accident Investigation Branch
AC	Alternating Current
AGL	Aeronautical Ground Light
AIP	Aerodrome Information Package
ALARP	As Low as Reasonably Practicable
AOA	Airport Operators Association
APAPI	Airport Precision Approach Path Indicator
ARP	Aerodrome Reference Point
ATC	Air Traffic Control
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
EMC	Electromagnetic Compatibility
EMF	Electromotive Field
FIS / FISO	Flight Information Service / Officer
FBC	Fareham Borough Council
FHA	Functional Hazard Assessment
GB	Great Britain
HV	High Voltage
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICNIRP	International Commission on Non-Ionizing Radiation Protection

Term / Abbreviation	Definition
IFA2	The IFA2 Interconnector, being developed by National Grid jointly with Réseau de Transport d'Électricité
ILS	Instrument Landing Systems
LED	Light-Emitting Diode
LV	Low Voltage
MEOSAR	Medium Earth Orbit Search and Rescue
MW	Megawatt
National Grid	National Grid Interconnector Holdings
NATS	National Air Traffic Services
NDB	Non-Directional Beacon
NG	National Grid Interconnector Holdings
NOTAM	Notice to Airmen
OFZ	Obstacle Free Zone
OLS	Obstacle Limitation Surfaces
RAF	Royal Air Force
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

1 INTRODUCTION

National Grid Interconnector Holdings (NG) is developing a new electricity interconnector facility, the Interconnexion France-Angleterre 2 (IFA2). The facility is being developed jointly with Réseau de Transport d'Electricité (RTE), the French transmission system owner and operator. It will link the United Kingdom's electricity transmission network with France's, and is expected to help enhance the security, affordability, and sustainability of energy supply to both countries.

The facility consists of two converter stations, one sited in each country. The UK converter station is to be sited to the north-east of Solent Airport at Daedalus ("Solent Airport"). National Grid proposes to route high-voltage direct current and high-voltage alternating current cables in a shared cable corridor to the west and north of the Solent Airport main runway.

The project is currently progressing through the detailed design stage and a large body of assurance evidence has evolved to examine whether the siting of the converter station and proposed routing of cables at Solent Airport could affect the airport's existing operations or future plans for the airport. This has considered in detail radio frequency interference (RFI) and electromagnetic field (EMF) effects, analysis of wind effects and airport safeguarding. In addition to this hazard identification and risk assessment has been undertaken and a hazard log developed, which records all risks, mitigation measures and the requirements / actions that need to be completed, in order to provide a robust safety justification that risks are acceptable as defined in CAP 760 [4].

This is an interim safety justification for the IFA 2 facility at Solent Airport that has developed through the project and details the body of evidence that, once complete, will provide a demonstrable and valid argument that potential safety risks posed by IFA2 should not adversely impact the airport's current operations or the known planned developments. It does not provide a safety case for the airport itself, however the information, documentation and references here may be used by RCAM to support a submission to the CAA under CAP 791 [5] demonstrating that the change to the airport by introducing IFA2 will be tolerably safe and will meet its specified safety objectives and requirements.

This safety justification document is supported by two addenda. Addendum 1 presents the current hazard log which details the status of the hazards and the assurance evidence at this point in time. Addendum 2 provides additional analysis and assessment to address some specific hazards in the hazard log and forms part of the assurance evidence referenced within the hazard log; this includes:

- A revised assessment of airfield safeguarding taking account of the IFA 2 design and updating the assessment in [2].
- Additional wind flow analysis carried out to supplement that in [2], [3] and [6]. This models interaction effects between the IFA2 converter station and the Faraday Business Park.
- Further technical assessment of EMF / RFI effects to confirm some assumptions made in the assessments in [2] and [3] and to consider some specific hazards within the hazard log that were not explicitly or fully covered by the body of evidence available.
- Assessment of UAVs and possible options for future improvements to the navigation environment at Solent Airport (including an instrument landing capability) which explore any potential hazards, risks or issues in the context of IFA 2 at Solent Airport. Currently there are no plans to introduce Instrument Landing Systems (ILS) or other navigation systems at the airport.

This safety justification document details the outcome of the hazard identification and risk assessment process, the safety objectives and requirements and the evidence providing the safety and technical assurance demonstrating that risks are acceptable. CAP 760 [4] has been used as the overarching standard and guidance concerning tolerability of risk, and the safety justification is structured in the format advised in this standard.

2 SCOPE

The scope of this safety justification is confined to considering possible hazards associated with the introduction of the IFA2 facility and how this may affect the Solent Airport (within the boundaries stated below), including the airport and airborne systems as well as the known future developments. Other potential causes of hazards which could affect airport operations (i.e. those arising from sources other than IFA 2) are not considered. This safety justification therefore may be used to support a safety justification for the airport but will not in itself provide an airport safety case, as this would need to address all hazards arising from all relevant equipment and operations.

The boundaries of the airport are shown in the most recent version of the Masterplan [7], which is reproduced in Appendix A. The scope of the safety justification covers the existing airport and airport operations within the boundaries shown on the Masterplan, together with the future planned changes to the airport described in Section 4.

The hazard identification and risk assessment supporting the safety justification has considered all aircraft in communication with, 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 have been excluded because the effect of buildings under Class G airspace is addressed by compliance with general regulations.

The scope excludes hazards and issues related to the construction phase of the project. These hazards are the responsibility of the main contractor appointed to construct the IFA2 facility and the cables, and control of hazards will be demonstrated through construction method statements and safety management plans put in place for the construction work. The main contractor will also implement a separate risk register in accordance with the Construction (Design and Management) Regulations to manage construction risks. Any interfacing hazards or issues between the construction phase and the operational IFA2 facility have been considered through the participation of the main contractor in the hazard identification workshops and hazard review meetings.

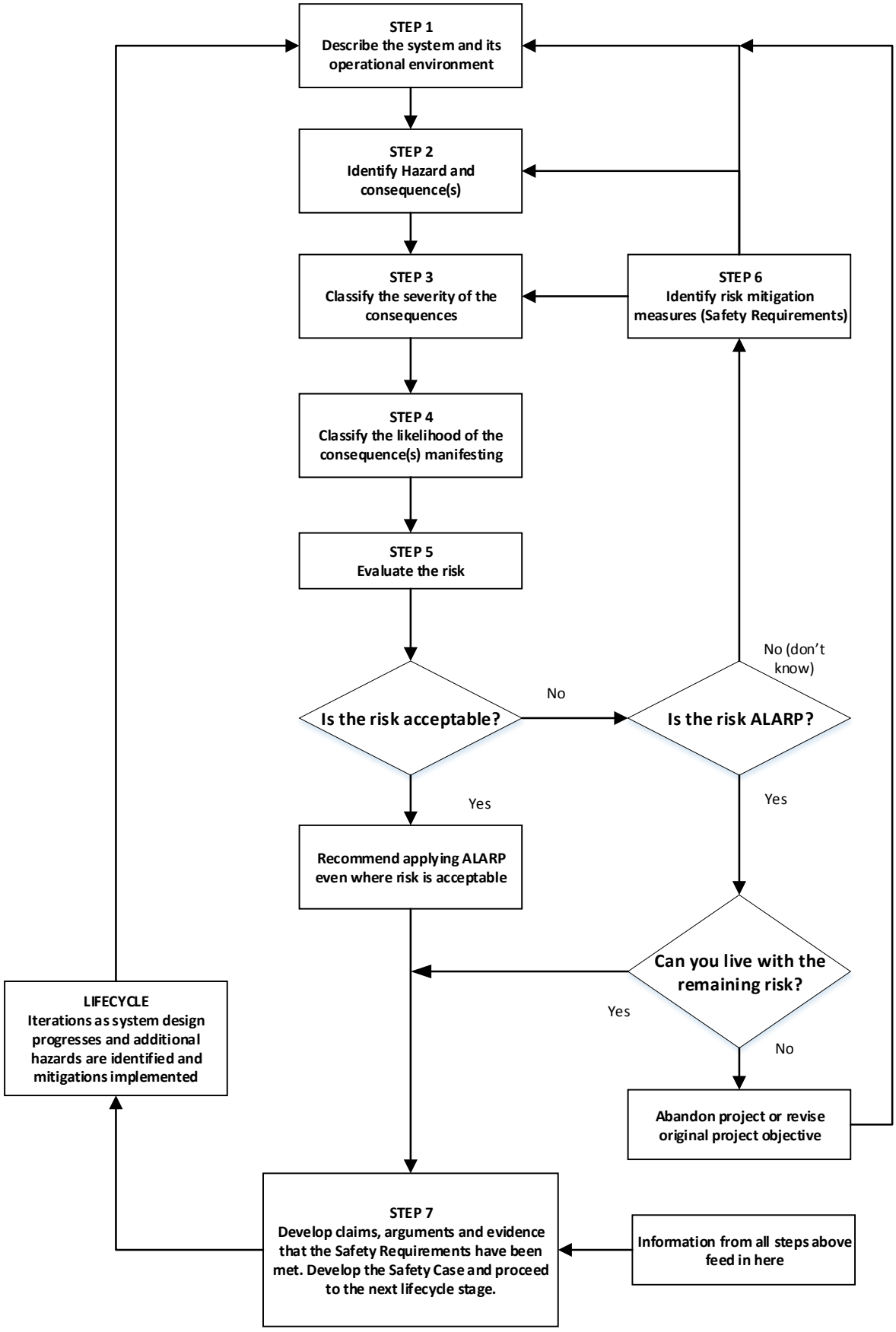
3 OVERVIEW OF HAZARD IDENTIFICATION AND RISK ASSESSMENT PROCESS

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 at the same time as, and supplementary to, the design process. This process starts at the concept stage with preliminary hazard analysis and develops through the design and implementation phases. Risk mitigation evidence is identified by more detailed hazard analysis in the hazard management phase, with any residual risks managed in the operational phase. Ultimately, the completion of this process demonstrates that hazards are eliminated where practicable, with residual risks acceptable and As Low As Reasonably Practicable (ALARP).

The hazard identification and risk assessment process adopted here follows a systematic Functional Hazard Analysis (FHA) approach that covers the Seven Steps for risk assessment in CAP 760 [4] as applicable in the project. This process is illustrated in Figure 1 below, which is extracted from CAP 760 [4]. Step 7 of CAP 760 [4], “claims, arguments and evidence that the safety requirements have been met and documenting this in a safety case”, can only be fulfilled within the constraints of this justification, (i.e. only in respect of the IFA2 facility and within the limits of the equipment and infrastructure stated on the agreed Masterplan).

Figure 1 – The Seven Step to Risk Assessment Approach (Extract from CAP 760 [4])



The purpose of the FHA is to:

- identify ways in which the proposed IFA2 installation might impair the safety of air traffic operations at Solent Airport (hazards) or have other adverse safety effects;
- identify how severe such impairment might credibly be;
- estimate the approximate likelihood of such impairment where possible.

The means of managing risk has developed progressively through the risk management process. Possible ways to manage risks identified during the FHA workshop are recorded in the hazard log, and have been developed through regular reviews of hazards aimed at managing the risks to closure.

An initial FHA workshop was held on the 24th August 2016 as part of the preliminary technical assessment [2] and a hazard log developed [8]. This work concluded that, based on the evidence available at the time, the risks posed by IFA2 were not expected to impact the airport's current operations adversely, and any hazards should be straightforward to manage.

A further hazard identification and risk assessment workshop was held on the 11th and 12th April 2017, described in [9], which developed the initial assessment and extended the hazards to include the plans for the development of the airport as known and specified at the time of the study. Additionally, the design specifications for the IFA2 facility had progressed at this stage, enabling the ranking of risks. This work also developed a plan for delivery of the risk mitigation evidence, which is given in [3] and is being maintained as a "live document" within the hazard log.

Since the 2017 workshop, the hazard log in [9] and the risk mitigation plan have developed; mitigation evidence has evolved with the detailed design. Although the assurance evidence is not yet complete, most of the analysis, calculations and assessments have been completed that support the detailed design and enable this interim safety justification to be completed. The issue of the interim safety justification at this stage is aimed at providing the necessary assurance to the FBC Executive Committee as planning authority, for full planning acceptance for the IFA 2 facility, obtaining the legal agreements and consent to progress to the next stage in the Project. Ultimately, as for any major project, the safety justification presented here will be fully complete, post construction when all the validation evidence from testing and commissioning is complete.

4 SYSTEM DESCRIPTION

This safety justification considers the possible effects that the proposed IFA2 facility could have upon Solent Airport's operations including the airport's airborne systems and operational functions, and equipment at the airport owned or operated by third-parties. The scope of the safety justification considers the airport's current operations and future changes to the airport and its operations, where details are known at this stage. Future changes considered here are based on the most recent version of the Masterplan [7], together with some additional known changes described (but not shown on the Masterplan).

4.1 The Airport and Airborne Systems

Solent Airport, located on the Solent shoreline between the villages of Stubbington and Lee-on-the-Solent, 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). The IFA 2 converter station is to be sited to the North East of Solent Airport.

Fareham Borough Council describes how it sees the future for its own land interest at Solent Airport in [10] 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.

Characteristics of Solent Airport itself are given in the airport manual [11]. The airport currently operates between 09:00AM and 16:30PM local time, seven days a week (or as published on the Airport website). For operations out of hours, agreements and prior permission is required for visiting aircraft. Future developments may extend the current operating hours.

The airport is currently used by a variety of organisations, including 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.

Developments completed to date at Solent Airport include:

- CEMAST College (a Centre of Excellence in Engineering and Manufacturing Advanced Skills Training, opened in August 2014);
- Fareham Innovation Centre, completed in March 2015, providing quality, affordable office/workshop facilities in a supported environment for small businesses;
- Construction of roads and services for development plots on Daedalus East, as the first phase of the commercial development.

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. Many of these future buildings will be located in the Faraday Business Park, which is located to the NE of the airport in the vicinity of the IFA 2 building as shown in Appendix A.

4.1.1 Safety Justification Boundaries

As stated above, the boundaries of the airport considered in this safety justification are shown in the most recent version of the Masterplan [7] and Appendix A. Existing airport operations are considered together with the known planned future changes affecting the airport and third-party equipment as summarised below.

Operational Changes

The current operational regime at the airport is to be upgraded to Flight Information Service (FIS). Whilst not full Air Traffic Control (ATC), FIS is an information system and can influence the onset or development of an incident.

Airfield Ground Lighting

Currently there is no Airfield Ground Lighting (AGL) at the airport. Incorporation of AGL on the main runway, as well as the future runway extension and other taxiways and aprons will be:

- Runway edge lighting.
- Airport Precision Approach Path Indicator (APAPI).
- Approach lighting.
- Upgrading of the Maritime Coastguard Agency (MCA) lighting.

Ducting for the AGL wiring has already been installed.

Navigational Aids

There are no plans at Solent Airport to implement Instrument Landing Systems (ILS) and Non-Directional Beacons (NDB). However, potential future options that may be available for the airfield to improve the navigation environment (including an instrument landing capability) have been considered within the scope in Addendum 2 to the safety justification in the event that such a system is installed in the future.

Fuel Installations and mobile fuel bowsers

The fuel installation consists of the following:

- The fixed fuel installation tank to be located at the bottom of the taxi way as shown on the Masterplan [7].
- The self-service tanks which will remain at the current location (the fuel farm) as shown on the Masterplan [7].
- Mobile bowsers that operate across the airport.

Compass Base and Pre- Flight Check Area Proposal

Compass Base:

The implementation of a compass base is a planned development and will be the defined area in which the compass will be calibrated for all aircraft. The location of the compass base is shown in the Master Plan [7].

Pre-flight check area:

The location of the planned pre-flight check area is yet to be decided, this is likely to be on the western side of the west taxiway. Once the location is decided, any potential impacts of IFA 2 need to be considered and confirmed to be acceptable. This is recorded as a dependency in Section 5.2.

Engine Testing Area

The location of the engine testing area has not been decided yet. However, it is likely to be near to or at the compass base. Potential hazards from IFA 2 related to the engine testing area were considered in the FHA, however no hazards were identified.

Runway extension and Taxiway extension

The planned runway extension is at the north end of the runway. It will be up to 100m length and to Code 3 status. Runway lighting will be extended.

The new taxiway is as shown on the Master Plan [7] and runs the full length of the current taxiway but may be moved slightly west by about 4 to 5m.

Weather Forecasting and Measurement Equipment

Weather forecasting and measurement equipment to be implemented in the future are:

- Visio meters; (Measurement).
- Cloud base recorder;
- AFTN lines (Airfield Fixed Telecoms Network), a messaging system to be introduced as part of the plan to introduce FIS.

Buildings

The buildings to be introduced as part of the IFA2 facility have been considered this assessment in terms of the potential effects on wind flow and airport operations.

The converter station building profile assumed for the assessment is Option B in [36], with the boundaries defined in [38].

Other buildings to be introduced in the vicinity of The IFA2 facility at the Faraday Business Park are shown on the Masterplan [7]. A “Sketch up” of these buildings in [36] was provided by FBC giving dimensions of the building. These buildings could potentially interact with the IFA 2 building to impact wind flow and this has been considered in Addendum 2 to this safety justification.

Drainage & Services and Ancillary Structures

Drainage and services relating to the IFA2 facility will be part of the installation and any additional fencing which is subject to Airport restrictions.

Aircraft Types

Aircraft types that could potentially be introduced in the future include:

- Civilian: up to 19-seater passenger jet, helicopters;
- MCA: helicopters;
- Military: Hercules, Apache, Chinook;
- Commercial UAVs (drones);
- Historic aircraft.

The current airport licence allows 40k movements per year. It has been assumed that this could rise to a maximum of 120k movements per year.

4.1.2 Airport Stakeholders

Stakeholders considered in the safety justification include existing and future known occupiers / users of airside facilities at Solent Airport as follows:

- Maritime and Coastguard Agency (MCA)
- Aerotech Solent
- Atlas Helicopters
- Bournemouth Avionics
- Britten Norman
- Hampshire Aeroplane Club
- Lee Bees Model Aircraft Flying Club
- Lee Flying Association
- Nason Energy
- Phoenix Aviation
- Portsmouth Naval Gliding Club
- Solent Microlights
- Deltair
- Malcom Paul
- Tiger Motorcycle Display Team
- TUV
- NATS
- MAST
- UTP

Potential future tenants considered are:

- Tekever

Future Third Party Equipment in Planning Process

Plans for third party equipment currently in the planning process are:

- NATS radar – this is used for training purposes only and there are no plans to convert it for operational purposes.
- An MCA satellite Local User Terminal (LUT) as part of the MEOSAR development.

4.2 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. The IFA2 facility will consist of two HVDC converter stations of similar construction, one sited in each country. The converters are connected by two 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 A.

HVDC and HVAC cables are 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 shown in Appendix B.

The alternating current (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 AC and supplied to the receiving transmission system. The interconnector can import and export 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 cables from Tourbe to Merville, France;
3. HVDC submarine cables from Merville, France to Monks Hill Beach, Daedalus;
4. HVDC land cables from Daedalus coast to the converter station at Solent Airport;
5. a converter station at Solent Airport;
6. HVAC connections (both submarine and underground) from the converter station at Daedalus to a National Grid Electricity Transmission (NGET) Substation at Chilling, Hampshire.

The nominal DC voltage is 320 kV. The nominal AC voltage is 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.

5 ASSUMPTIONS AND DEPENDENCIES

A safety justification must state clearly the hazards from and dependencies on other facilities or external services or activities and related claims or assumptions that should be substantiated, in order to complete the safety justification. These are stated in Section 5.1 below. The list of dependencies in Section 5.2 include all the actions and activities identified in the Hazard Log and the risk mitigation plan shown in Appendix C.

Some of the dependencies listed in Section 5.2 are related to this safety justification as they ensure control of risks but are subject to a separate safety management programme and are not a constraint on the IFA 2 programme. This occurs for example, where a third-party system which interfaces with IFA 2 is planned, and testing for compatibility or a procedure will be required before the third-party system is brought into operation. The table in Section 5.2 therefore states which dependencies are a constraint on IFA 2 i.e. must be completed within the safety management programme for IFA2, and those which are not, i.e. those related to the programme for third-party systems. The table also provides a status against each of the dependencies which is current as at the date of issue of this safety justification.

5.1 Assumptions

Table 1 – Assumptions

No	Assumption
A01	Wiring for AGL will be routed in the ducting already installed.
A02	AGL lighting implemented will be compliant with airport standards.
A03	IFA2 facility as built will be as per the specifications which form the basis of this safety justification. Any changes will require review / re-assessment.
A04	The wind flow assessment is based on the masterplan [7] as provided by FBC, and the dimensions and layout of the buildings on this development have been used
A05	Not used.
A06	The planned runway extension will be up to 100m and to Code 3 status.
A07	Future aircraft movements at Solent Airport could rise to a maximum of 120k movements per year.
A08	Drainage systems at Solent Airport are of non-metallic / conductible materials.

5.2 Dependencies

The status of dependencies assigned below uses the following definitions, for further detail of the actions remaining to fulfil each dependency refer to the risk mitigation plan in Appendix C:

- “Design” – there remain actions relating to the design or the design still needs to be finalised.
- “Testing” – all actions relating to the design are complete and testing is required once the facility is operational.
- “Management” – there are no design or testing actions remaining, ongoing management or a procedure is required.
- “Closed” – all actions to fulfil the dependency are closed.

Table 2 – Dependencies

No	Dependency	Constraint on IFA2	Status
M01.1	Confirmation of the final IFA 2 external flood lighting design.	Yes	Closed
M01.2	External security lighting design details to be finalised with confirmation that this meets guidelines for lighting near airports in AOA advice note 2 [32] and BS 5489 'Code of Practice for the Design of Road Lighting [30] as appropriate.	Yes	Closed
M01.3	Final confirmation / agreement that Planning Condition No 10 concerning building external lighting is met.	Yes	Design
M02.1	Confirmation that there are no road / highway lighting changes related to IFA 2 at final detailed design.	Yes	Closed
M03.1	Confirmation that the final converter station building cladding design is as per the design specifications.	Yes	Design
M04.1	The final version of the noise report -1JNL575900 "Audible Noise - Assessment for Planning Application" [25] to be issued.	Yes	Closed
M04.2	Confirmation that the noise emissions from the IFA 2 facility during operation meet predictions in the noise report [25].	Yes	Testing
M04.3	Final confirmation / agreement that Planning Condition No 11 and legal agreements concerning noise emissions are met.	Yes	Testing
M05.1	RCAM to notify updates on IFA 2 site activities to airport users and tenants through NOTAMs over the construction and operational periods.	Yes	Management
M05.2	NG has a process in place to provide regular updates on IFA 2 site activities to RCAM over the construction and operational periods.	Yes	Management
M08.1	Confirmation that choice of trees for landscaping is in accordance with RCAM tree schedule.	Yes	Closed
M08.2	FBC has a process in place to manage vegetation growth.	Yes	Management
M11.1	RCAM has a Bird Hazard Management process in place updated for IFA 2.	Yes	Management
M11.2	RCAM, wildlife experts and planning team agree on plans for water features in the landscaping design in the context of bird hazard management.	Yes	Closed
M12.1	Safe means of access to building roof and guttering for clearing bird nests.	Yes	Design
M13.1	Detail of roof, including any bird deterrent measures, to be confirmed in the detailed design.	Yes	Design
M16A.1	FISO radios to be tested prior to IFA 2 and when IFA 2 energised to identify any dead spots.	Yes	Testing
M16A.2	RCAM has procedures in place to manage any radio dead spots identified.	Yes	Management
M16B.1	Survey carried out prior to IFA 2 and when IFA 2 energised to identify any dead spots affecting emergency services radios.	Yes	Testing
M18.1	Start of operations advised by RCAM to airfield users through email.	Yes	Management

No	Dependency	Constraint on IFA2	Status
M19A.1	Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits.	Yes	Testing
M19A.2	Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met.	Yes	Testing
M19A.3	Compass base confirmed as implemented with all signage, airfield markings and instructions in place before IFA 2 is energised.	Yes	Testing
M20.1	Pre-flight check area confirmed as implemented with all signage, airfield markings and instructions in place before IFA 2 is energised.	Yes	Design
M24.1	Procedure implemented before FISO introduced that retains the existing rule regarding only authorised vehicles allowed airside.	No	Management
M26.1	Testing completed that demonstrates acceptable RFI emissions.	Yes	Testing
M26.2	Final confirmation / agreement that Planning Condition No 14 and legal agreements concerning RFI emissions are met.	Yes	Testing
M27.1	FBC impose the requirements for testing by MCA under the legal agreements for MEOSAR and compliance confirmed.	No	Testing
M28.1	Detailed construction method statement and detailed scheme with cable arrangements in place.	Yes	Management
M28.2	Monitoring of electro-magnetic fields once operational to confirm that planning conditions are met.	Yes	Testing
M28.3	RCAM submission under CAP 791 “Procedures for Changes to Aerodromes” incorporating IFA 2 and CAA endorsement in place.	Yes	Management
M29.1	FBC impose the requirements for testing by NATS under the legal agreements for radar and compliance confirmed.	No	Testing
M30.1	Preliminary impressed voltage assessment for cables at Daedalus finalised and plans implemented.	Yes	Design
M31. 1	RCAM has procedures and controls in place for UAVs, before UAVs permitted to fly at Solent Airport.	No	Management
M32.1	Detailed design for the fire protection / suppression systems complete and as per the system description.	Yes	Closed
M32.2	Confirmation that fire protection / suppression system in place is as per the detailed design.	Yes	Testing
M34.1	RCAM has procedures for FISO in place.	No	Management
M37.1	Threat assessment for the Airport updated for IFA2 and measures in place to manage threats as required.	Yes	Management
M40.1	The interface between the AGL wiring layout and the HV cable design to be checked for touch potential / impressed voltage hazards and suitable mitigation implemented as necessary.	No	Design
M43.1	Safety step and touch voltage study for the converter building issued and plans implemented.	Yes	Design

6 SAFETY OBJECTIVES

CAP 760 [4] defines Safety Objectives as "the definition of a hazard together with its target maximum rate of occurrence. A goal or target that, where achieved, demonstrates that a tolerable level of safety is being, or will be achieved for the hazard concerned."

This safety justification is considering the change being introduced to Solent Airport through the introduction of IFA 2 and identifies the potential hazards and risks that may have an impact on the safety of aerodrome operations or air traffic services (ATS). The hazard identification and risk assessment process has followed a systematic FHA approach that covers the Seven Steps for risk assessment in CAP 760 [4] as described in Section 2.

Risk is a combination of the likelihood of occurrence and the severity of the consequences of a hazard. Severity and likelihood classifications from Solent Airport's SMS [11] were used, which are identical to those of CAP 760 [4], but also include Solent Airport's processes for managing safety risk. Both severity and likelihoods have been assigned to most of the hazards in the Hazard Log. At the time of the FHA the mitigation measures were evolving, hence the likelihood set for most hazards is a target and the mitigation evidence is the means of demonstrating that this target is met.

The hazards identified from the FHA that has been carried out together with the likelihood targets to be demonstrated are summarised below, listing hazards from highest to lowest consequence severity.

Severity Classification (CAP 760)	Definition	Hazards in this Category	Target Likelihood
"Accident"	Accident - as defined in Council Directive 94/56/EC1 for air traffic services. Also includes loss of or substantial damage to major aerodrome facilities. Serious injury or death of multiple staff/ members of public at the aerodrome.	None	N/A
"Serious Incident"	Serious Incident - as defined in Council Directive 94/56/EC1 for air traffic services. 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.	HAZ20 - High 50Hz impressed voltages or touch potentials due to LV cabling or fencing.	To be eliminated by the design.
"Major Incident"	A major incident associated with the operation of an aircraft, in which safety of 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	None	N/A

Severity Classification (CAP 760)	Definition	Hazards in this Category	Target Likelihood
	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 Incident"	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.	HAZ01: Distraction of aircrew; HAZ02: Wind impact, caused by building (turbulence and unexpected changes in wind patterns, wind shear and so on); HAZ03: Bird strike; HAZ10: Distraction of control tower staff; HAZ11: Impaired ground to ground communications; HAZ17: Terrorist attack on IFA2; HAZ18: Exposure of public and workers to excessive magnetic fields; HAZ19: Incorrect magnetic compass reading; HAZ21: Loss of control of Unmanned Aerial Vehicle (UAV); HAZ22: Fire and smoke; HAZ24: Incorrect ground lighting intensity; and HAZ25: Wrong or no altimeter reading.	Remote: Unlikely to occur during the total operational life of the system. 10^{-5} to 10^{-7} per hour. Once in 10 years to once in 1000 years. (or better)
Not Assigned		HAZ26: Unknown effect on MCA operations; HAZ27: Unknown effects on Britten-Norman operations; and HAZ28: Unknown effect of NATS operations.	These hazards concern the interface of IFA 2 with third partly systems. Risks are subject to the third-party safety management system and are not ranked here. The objective here is to demonstrate with the highest level of confidence that there are no adverse impacts that would impact

Severity Classification (CAP 760)	Definition	Hazards in this Category	Target Likelihood
			the third-party system from introducing the IFA 2 facility.

7 SAFETY REQUIREMENT DERIVATION

Step 6 of the CAP 760 Seven Steps to Risk Assessment covers derivation of safety requirements. The risk mitigation measures that are necessary for the system to meet the safety criteria are referred to as Safety Requirements, and must be clearly documented. These safety requirements must be met before putting the system into operational service.

Step 7 of the CAP 760 process "claims, arguments and evidence that the safety requirements have been met and documenting this in a safety case" then addresses the arguments and evidence required to show that each safety requirement has been satisfied. However, this step can only be fulfilled in respect of the IFA2 facility and within the limits of the equipment and infrastructure stated on the agreed Masterplan [7].

The criticality of a safety requirement and the confidence level of assurance necessary, depends on the risk. The more likely and more severe the consequences then a higher level of assurance is required to provide confidence that the safety requirement is met.

Safety requirements have been derived through the FHA in the form of the mitigation measures required to close out the hazards. The hazard log tracks all the hazards, the risk assessment and the risk mitigation measures for which assurance is necessary. The evidence providing the assurance is being collated through the risk mitigation plan as described in [3].

Some of the key safety requirements are formalised as constraints through planning conditions and the legal covenants in the Converter Station Lease. Two of the key planning conditions which concern radio frequency interference and electromagnetic field emissions are highlighted below. Other relevant conditions and the legal covenants concern noise emissions and external lighting.

- "Planning Condition 14 - No development relating to the erection of the converter station buildings shall take place until details setting out how the converter station buildings will be designed and implemented to ensure that any electromagnetic disturbance arising from the use of the site does not prevent radio and telecommunications equipment or other equipment outside the site from operating as intended, has been submitted to and approved in writing by the local planning authority. The development shall be undertaken strictly in accordance with the approved details. REASON: To prevent radio frequency interference to users of surrounding land and buildings".
- "Planning Condition 48 - No development in relation to the Installation of cables on Daedalus Airfield shall take place until details of the way in which the cables will be arranged below ground along with the depth at which the cables will be laid has been submitted to and approved by the local planning authority in writing to the achieve the following: - a)Alternating Current magnetic fields directly above the cables not more than 10 micro tesla when measured at ground level at each taxi-way crossing of the cables; b) Direct Current magnetic fields directly above the cables not more than 10 micro tesla when measured 1.5 metres above ground level at each taxi-way crossing of the cables; c) compass deviation not more than 1 degree when 12 metres or more away from Direct current cables, measured at 1.5 m above ground level at each taxi-way crossing of the cables. The installation of the cables on Daedalus Airfield shall be undertaken in accordance with the approved details. REASON - To ensure Alternating and Direct Current cables at the site will not materially impact upon aviation use and safety at the site".

8 SAFETY REQUIREMENTS

As explained above, safety requirements are generated from the hazard identification and risk assessment process. CAP 760 [4] defines a safety requirement as a:

"*Specified criteria of a system that is necessary in order to reduce the risk of an accident or incident to an acceptable level. Also a requirement that helps achieve a Safety Objective.*"

For example a safety requirement may be set for an engineered design item to be compliant with a standard or to have certain properties or design features in order to ensure that the risks are acceptable, as assessed through hazard identification and risk assessment.

Through the FHA, mitigation measures have been set which once validated, will ensure that risks associated with the IFA 2 facility at Solent Airport are acceptable. These mitigation measures therefore form safety requirements.

CAP 760 [4] also sets guidelines for the minimum confidence levels for the validation evidence showing compliance with the safety requirements. This is based on the risk associated with the corresponding hazard.

8.1 Guidelines on Acceptable Levels of Evidence (CAP 760)

CAP 760 [4] includes guidance on the level of evidence required, which for convenience is summarised below:

High confidence evidence:

- uncertainties or assumptions are minimised, erring on the side of pessimism i.e. the worst is assumed;
- substantial and diverse forms of evidence should be used e.g. testing, field service and analytical evidence;
- for equipment and systems supplied by third parties, the cooperation of the supplier is essential because design specifications, manufacturing specifications, design test results and quality assurance data is typically required to support claims and arguments;
- where possible evidence should be subjected to independent scrutiny through, rigorous internal or external quality assurance inspection or audit.

Medium confidence evidence

- uncertainties or assumptions are minimised or err on the side of optimism i.e. the worst may not be assumed.
- the quantity of evidence should be balanced to the risk.
- at least two diverse forms of evidence should be used e.g. testing, field service and analytical evidence;
- for equipment and systems supplied by third parties, the cooperation of the supplier may be required because design specifications, manufacturing specifications, design test results and quality assurance data may be required to support claims and arguments.
- where possible, evidence should be subjected to independent scrutiny through internal or external quality assurance inspection or audit, however a sampling approach to the audit may be used.

Low confidence evidence

- uncertainties or assumptions are minimised or err on the side of optimism i.e. the worst may not be assumed.
- the quantity of evidence may be low.
- only one form of evidence may be required, however it is recommended to use more than one form of evidence.
- for equipment and systems supplied by third parties, design and manufacturing evidence may not be required, unless it can be provided cost effectively. However good working practice will still need to be demonstrated so some information from the supplier organizations may be required.
- the evidence should be subjected to scrutiny through inspection or audit, however a sampling approach may be used.

8.2 Risk Mitigation Measures and Confidence Level of Assurance

Appendix C lists the safety requirements which are derived from the hazard log (Addendum 1 to this report) and the risk mitigation measures required to control risks. The safety requirements are numbered based on the mitigation measures defined in the hazard log (Addendum 1 to this report). The table in Appendix C also defines the minimum confidence level required from the mitigation evidence demonstrating compliance, which is generally based on the risk categories assigned to the relevant hazards in the hazard log.

Appendix C also shows the traceability to the dependencies listed in Section 5. Dependencies are stated where all the evidence to demonstrate compliance with the requirement is not currently available.

Liaison has taken place with third party agencies to fully understand any potential hazards and risks (both business and safety risks) related to the interfaces with IFA 2 and the mitigation measures required. Risk rankings however have not been assigned to these hazards. This is because these hazards are subject to the safety management system of the third-party organisation as well as the Airport SMS, including their criteria for tolerable risk (both business and safety risks). It is thus not considered to be appropriate to assign risk rankings to them. For these hazards, a pessimistic approach has been adopted in defining the evidence required, with the objective of demonstrating with the highest level of confidence (based on CAP 760 guidelines), that there are no adverse impacts that would impact the third-party system from introducing the IFA 2 facility at Solent Airport.

9 SYSTEM ASSURANCE

This section of the report describes the process followed and analysis carried out within the defined scope to provide assurance that the potential safety risks posed by the IFA2 facility upon Solent Airport's operations, systems and equipment can be appropriately managed and are acceptable as defined in CAP 760 [4].

The core hazards associated with IFA 2 were identified very early during the planning stage for IFA 2. These are.

- Hazards to be considered as part of aerodrome safeguarding as identified in CAP 738 [1] include any potential impacts on airport operations (e.g. obstacle limitation surfaces, lighting, and bird hazard management).
- Electromagnetic field (EMF) and radio-frequency interference (RFI) emissions from the converter station, the equipment and HV cables with potential impact on airport and aircraft operation.
- Wind flow effects caused by the IFA 2 building and potential safety impact on flying operations.

As described in Section 3, following this initial assessment, formal FHA was completed to identify all hazards associated with IFA 2 that could cause an increase in risk on airport and aircraft operations as well any other foreseeable hazards / risks. Hazards and risks resulting from these studies are recorded in the hazard log.

The development of the assurance evidence also commenced at a very early stage in the project. This focussed initially on high level analysis and generic calculations and technical assessment which have now significantly developed as the project has progressed. The detail design of IFA 2 is now well under way and a large body of assurance evidence has evolved. There are plans in place to implement an extensive programme testing to validate the analysis and calculations and to demonstrate that safety requirements, planning conditions and legal requirements are met. The body of assurance evidence discussed below falls into the following categories:

- Analysis, calculations and assessment.
- Wind tunnel testing.
- Testing and trials.
- Independent Scrutiny.

Hazard review meetings have taken place as the project lifecycle has progressed to collate the evidence, as follows:

- Hazard Review Meeting on the 25/5/17 (attended by RCAM, NG, FBC, Arcadis).
- Hazard Review Meeting 27/6/17 (attended by NG, Arcadis).
- Review of mitigation plan 21/7/17 (attended by FBC, Arcadis).
- Review of MCA hazards 21/7/17 (attended by MCA, RCA, Arcadis).
- Hazard Review Meeting 10/8/17 (attended by RCAM, NG, FBC, Arcadis).
- Review of Hazard Log Actions 23/8/17 (attended by FBC, NG, Arcadis).
- Hazard Review Meeting 1/11/17 (attended by FBC, NG, Arcadis)

Liaison with the converter station Main Contractor (ABB) and HV cable contractor (Prysmian) has taken place through conference calls and NG/contractor liaison meetings as the design has developed.

There is a regular working group meeting held involving FBC and NG and NG has set up a weekly progress meeting to monitor progress in implementing the risk control measures that provide safety assurance evidence.

9.1 Analysis Assessment and Calculations.

The following sections provide an overview of the analysis, technical assessment and calculations that have been completed focussing on the main potential hazards associated with IFA 2 i.e. EMF/RFI emissions, aerodrome safeguarding and wind flow effects.

9.1.1 Electrical Hazards, including EMF / RFI Emissions

During 2016, analysis in [12], [13] and [14] was commissioned by National Grid to investigate the possible effects of EMF and RFI that the converter station and cabling might present at Solent Airport. These preliminary studies were undertaken at the planning stage, when a detailed design of the converter station was not available, hence they included assumptions relating to the design and specifications of the converter station.

This work concluded that there is a very low probability of interference to airport communication systems, potential future navigation systems (e.g. ILS) and no credible safety risk to aircraft equipment. The preliminary analysis of EMF / RFI effects that supported this view, predicted that the overall impact is negligible, the potential exists however for some small localised effects which could be mitigated as follows:

- A possible risk of interference to aircraft receivers operating in areas of the airport close to the converter station had been predicted. However, 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.
- Some possible localised deviation of heading indications on compass systems and magnetometers due to DC and magnetic fields, mainly for aircraft on the ground close to the HV cables. However, the deviation predicted was small and indications quickly returned to the correct indications once a short distance away from the localised area;
- Some potential for interference to local high-frequency, medium-frequency and low-frequency radios, but with limited effects and only for radios very close to the converter station.
- Whilst not presenting any safety hazard, an initial assessment of possible shadowing of terrestrial television transmissions for the Rowridge transmitter on the Isle of Wight in [12] was undertaken. This concluded that the risk of any shadowing effects causing interference is low.

Since this initial analysis further, more detailed assessment of EMF / RFI effects has been undertaken which has refined the initial findings and substantiated that effects (if any) would be very small and localised. This includes:

- Further RFI assessment for IFA2 [15];
- Aircraft Magnetic Field Susceptibility Assessment [16];
- Islander and Defender Magnetic Field Susceptibility [17], [18] and [19];
- Further TV and Radio Reception Studies [20] and [21];
- An RF Survey Test Report for the IFA2 Development at Solent Airport [22];
- A Radio and Telecomms Interference and EMF assessment [35],
- A High Frequency (HF) filter performance study [41].
- Surveys assessing potential impact to mobile phone networks and emergency services radios [43] and [44].

The assessments in [22], [35] and [41] have considered the limits for the level of RFI emissions that can be tolerated from the converter station, based on a report by the Council on Large Electric Systems (Cigré), Report 391 [24]. The most recent assessments undertaken by the designer of the converter station (ABB) document [41] expect RFI emission levels to be at or below background radiation levels at 30 m from the converter station for frequencies < 10 MHz. For frequencies >10MHz, the emission levels are expected to be even lower.

The Arcadis technical assessment in [3] carried out an independent peer review of the analysis available in February 2017 and also identified a few areas where further technical assessment may be necessary to supplement the evidence required by the hazard log. Addendum 2 to this safety justification document provides further technical assessment to complete this evidence including:

- Independent peer review of the more recent analysis in [21], [22] and [35].
- Further consideration of potential risks related to EMF / RFI effects on the MCA equipment and operations.

- Further consideration of potential risks related to EMF / RFI effects should UAV operations or possible improvements to the navigation environment (including an instrument landing capability) be introduced to Solent Airport in the future.

With the detail design now developing, the Main Contractors are planning further analysis and calculations to demonstrate that some of the potential hazards relating to impressed voltages and touch potentials are eliminated. ABB has completed a preliminary assessment of touch voltages [42] for the converter station and Prysmian (the HV cable contractor) has undertaken a “preliminary impressed voltage assessment for cables at Daedalus” [31], stating their intentions for further assessment of earth potential rise during fault conditions and impressed voltages due to magnetic coupling.

9.1.2 Aerodrome Safeguarding

In 2016, Arcadis carried out an assessment of aerodrome safeguarding in relation to the IFA2 Interconnector Facility in [2] based on the assumptions at that time concerning the converter station design. The primary purpose of aerodrome safeguarding is to protect aircraft from obstacles and obstructions whilst operating in the vicinity of airports. With regard 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.

Overall, the plans for the IFA2 converter station were found not to conflict with aerodrome safeguarding criteria. A few minor issues were identified to consider when developing the final plans and detailed design, but the general principle of the development to date was considered to be acceptable and any safety risks were expected to be acceptable in accordance with CAP 760 [4].

- 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. The roof design is now confirmed as pitched and dependency M12.1 captures the need to specify the access arrangements for maintenance.
- 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. This is captured in dependency M01.2.

The safeguarding assessment in [2] has been updated in Addendum 2 to this report with the detailed design information now available and it is confirmed that there are no conflicts with aerodrome safeguarding. Recommendations from the safeguarding assessment are captured as dependencies.

9.1.3 Wind flow effects

A preliminary qualitative assessment of the likely impact of the IFA 2 converter station on wind flow encountered at Solent Airport was commissioned by National Grid in [21]. This predicted that any effects on wind flow from the converter station were small and risks to aircraft taking off or landing at Solent Airport is acceptable. Arcadis carried out a peer review of this work and performed independent analysis using computational fluid dynamic analysis in [2] and [6]. This work was repeated in [4] for the revised profile of the IFA2 converter station and modelled the landscaping.

The analysis in [4] modelled the converter station buildings and included details of the landscaping in the immediate vicinity of the of the building. This work concluded that effects of the buildings on the wind flow were small; the highest relative increase in wind speed onto the main runway caused by the building being a maximum of 39% at a height of 10m above the ground in the wind speed cases of 10m/s. At low wind speeds like 5m/s, the building has little to no impact on the main runway at the wind direction of 70° EoN. Similarly, at wind speeds more than 5m/s that are coming from the direction of the building onto the main runway, there is no significant building wake impact at 20m or more above the ground.

Analysis in Addendum 2 to this report, includes the converter station together with more of the immediate surroundings, in particular, the Faraday Business Park. This assumed estimated dimensions of the building

based on the expected profiles of the future building. The purpose of this analysis is to examine any possible interaction effects between the converter station and other buildings that could impact the wind flow on the runway. This analysis concludes that the future faraday business park buildings both act as a shield to the converter station and have the overriding impact on the runway. The worst-case angle changes from 70^0 to 90^0 EoN. At this angle, the buildings nearest the runway produce three tails of faster winds, which covers the biggest area on the main runway compared to the other angles. The highest relative increase in wind speed onto the main runway caused is a maximum of 29% at a height of 5m above the ground.

It is recommended that the configuration of these “frontline” buildings nearest the runway is reviewed to minimise any wind flow effects.

It was confirmed at the hazard identification and risk assessment study reported in [8] and [9] that localised changes in wind patterns are easily managed and that pilots quickly become familiar with any changes in wind patterns and adapt their flying accordingly through good airmanship.

9.2 Wind Tunnel Testing

Since the completion of the wind flow analysis in Addendum 2, NG has commissioned additional work to simulate the wind flow around the converter station within a wind tunnel. This work is reported in [40]. The wind tunnel testing considered the converter station and the surrounding landscape together with the some of the adjacent hangars which are part of the Faraday Business Park currently under construction.

The wind tunnel testing provides an opportunity to compare the results with the CFD wind flow modelling and to give reassurance of the reliability and accuracy of the wind analysis results, as well as providing further confidence in the proposed design. A further CFD wind flow analysis has therefore been carried out to model the same building configuration within the Faraday Business Park as in the wind tunnel, and the results have been compared.

Both the wind tunnel testing and the CFD wind flow analysis confirm all previous predictions that the wind flow effects are small and localised.

The comparison of the detailed results shows that:

- the wind speeds predicted by the CFD wind flow analysis are generally higher compared to the wind tunnel testing. This could be due to a number of reasons, such as the turbulence model used, or the surface roughness in the model;
- there is a strong correlation between the two sets of results where the discrepancy is within a 15% margin, the CFD wind flow analysis being generally on the pessimistic side;
- the general trends of the CFD wind flow analysis results are in line with wind tunnel results, in respect of wind speed increases in relation to the height from ground level.

9.3 Testing and Trials

9.3.1 EMF Testing for the HV AC and HVDC Cables

Testing is planned both during the pre-construction phase and during the testing and commissioning of IFA 2 post-construction. This is aimed at valdating computer models and ultimately at demonstrating compliance with the relevant planning conditions and legal agreements concerning EMF emissions.

The analysis described in Section 9.1.1 uses computer software models to predict the electro-magnetic fields (produced by the HVAC cables) and compass deviation (produced by the HVDC cables) based on the configurations and currents proposed for the AC and DC circuits. This predicts that any EMF effects from the HV cables (both AC and DC) are very small and localised. Initial testing, reported in [45] has now been completed to provide confidence to all stakeholders that the calculations do indeed yield the correct results for the fields produced by cables, that the planning conditions and legal agreements concerning EMF emissions will be met and therefore that it is appropriate for IFA2 to proceed with the installation of the cables. Additionally, testing reported in [46] has given confidence regarding the calculations predicting that there are no adverse impacts from EMF emissions on aircraft and aircraft systems.

The cable tests described in [45] were performed in three stages as follows:

1. **Seven tests on five existing National Grid cables**. These are designed to validate the general principle that the calculations are capable of predicting measured fields in a range of circumstances.
2. **A test on the design of cables proposed at Solent Airport**, conducted on samples of these cables laid out at ground level at Prysmian's test facility at Bishopstoke. These are designed to validate that the calculations predict the correct field for the design of cables proposed for Daedalus, but do not reproduce the correct depth of burial, as the cables are laid on the surface.
3. **A test on a length of the cables buried in the proposed configuration at Solent Airport**. These are designed to validate calculations of field for the full geometry of the actual cables, including the approximate depth of burial.

The tests in 2 and 3 above simulated the maximum electro-magnetic field that that would be generated by the final cables. IFA2 is likely to include screening of the magnetic fields where the cables cross the taxiways, partly to ensure that the planning conditions are met with a comfortable margin. None of the existing National Grid cables have any screening of the magnetic field. The test at Prysmian included both screened and unscreened cables. The test at Daedalus was for screened cables.

The main findings regarding the calculation of electromagnetic fields and screening are summarised below:

- Calculations of AC and DC magnetic fields and of compass deviation do indeed predict the actual fields that are produced with considerable accuracy.
- IFA2 will be designed with a specified depth of burial such that, even allowing for any potential variations in the placing of the HV cables, the electromagnetic fields produced will be compliant with the planning conditions.
- AC screening of the type and specific design proposed ("passive loop screening") reduces the magnetic fields by a factor of about two.
- DC screening of the type proposed (a ferromagnetic screening tube) reduces the magnetic fields and the compass deviation by a factor of at least two and possibly more.
- For the final IFA2 cables, the screening material for the DC screening will have been developed further, and it is anticipated that the screening factor will be greater than was observed in these tests.

The testing reported in [46] used the length of cable buried at Solent Airport to assess the impact on actual aircraft and aircraft systems provided by third party organisations for use in the tests. The aircraft tested, which included a helicopter and a drone (UAV), were located directly above the buried cable and effects were measured through the instrumentation readings. All representatives from the organisations involved reported that the aircraft systems tested during the trial functioned as normal and no anomalies were observed on any of the aircraft avionics during the trials. Compass deviation on magnetic compasses was noted to be between 2 and 3 degrees. Fluxgate compasses exhibited negligible deviation".

Further EMF testing of the cables is planned post-construction, during the testing and commissioning period for IFA 2 in order to demonstrate compliance with the planning conditions and legal agreements for the as-built facility.

9.3.2 RFI Testing for the Converter Station.

During the IFA 2 testing and commissioning phase, when the station is ready to be energised, measurements of disturbance levels around the station will be performed in order to verify compliance with requirements regarding emissions and in particular the relevant planning conditions and legal agreements.

Measurements of background RF will be taken at specified locations with IFA 2 de-energised and energised with full load respectively. These measurements will be compared with limits based on the standard CIGRE TB391 [24] in order to validate the predictions in [35] and [44] and to demonstrate compliance with the planning conditions and the legal agreements.

9.3.3 Other testing

Other testing planned to complete the mitigation evidence is as follows:

- Noise measurements during testing and commissioning of the converter station to confirm predictions in the noise report [23] and to comply with planning and landlord requirements.
- Testing of FISO radios before and after IFA 2 is energised. This is subject to RCAM's programme for introducing the radios and is not a constraint on the IFA 2 programme.
- Testing of third party installations i.e. the MCA MEOSAR satellite station and the NATS radio as part of the legal agreements for the MCA / NATS planning process. This process is managed by FBC as planning authority in accordance to their programme and is not a constraint on the IFA 2 programme.

9.4 Independent Scrutiny

As discussed above, in 2016 and 207, Arcadis were commissioned by NG together with FBC to carry out an independent peer review of the analysis for EMI and RFI effects, also the initial analysis of wind effects in [21]. These peer reviews are reported in [2] and [3]. Recommendations were raised in these reports to develop the analysis as the design of IFA 2 progressed in order to provide a robust safety and technical justification for EMF and RFI effects and these recommendations have either been addressed or are planned to be addressed, all safety related actions still to be complete being recorded as dependencies.

FBC as planning authority commissioned their own peer review of the EMF / RFI analysis discussed in 9.1 above. The TÜV-SÜD report [24] is a peer review of documents relating to EMF and RFI effects arising from the IFA2 facility, including a peer - review of a draft version of the Arcadis report that was eventually issued in [2].

10 LIMITATIONS AND SHORTCOMINGS

In accordance with CAP 760 [4] guidelines, a safety justification should state clearly:

- any deficiencies found with the system;
- any safety objectives or requirements that have only partially been proven, have failed to be proven or have insufficient evidence to provide the required level of confidence (except those requirements where further validation work is already planned);
- any counter evidence for the system i.e. any evidence that demonstrates that a requirement is not met.
- any assumptions for the system for which there is no, or insufficient validation or rationale.

This document demonstrates that in the context of providing a safety justification for The IFA2 facility at Solent Airport there are no limitations or shortcomings. All further validation work that is required to demonstrate safety requirements is recorded as dependencies and is planned in the project programme. All assumptions made require confirmation however they all have a strong rationale behind them.

11 ONGOING MONITORING

This section identifies those safety requirements that require ongoing monitoring.

Assumptions in Section 5.1 require confirmatory checks to ensure they remain valid.

The closure of the dependencies in Section 5.2 require ongoing monitoring over the project lifecycle in order to complete the safety justification. Some of these simply requiring confirmatory checks on the final detail design, others require validation evidence through testing. Some of the dependencies are subject to other safety management programmes and are not constraints on the IFA 2 programme.

Safety requirements related to operational controls will require ongoing monitoring beyond the IFA 2 design and construction programme. These controls are normal airport procedures; hence it is expected that this will be managed through the RCAM safety management system [11]. The RCAM safety management system may require update to include IFA 2 however actions are raised for this where necessary as dependencies in 5.2.

12 CONCLUSIONS

This safety justification presents the body of evidence which collectively, once all evidence is available, will demonstrate the safety of the IFA 2 facility within the boundaries of Solent Airport. The scope considers hazards related to IFA 2 at Solent Airport; there is no consideration of other hazards to the airport. This safety justification does not provide a safety case for the airport itself, however the information in this safety justification may be used by RCAM as Airport Operator to update the airport safety management system [11] and to support a submission to the CAA under CAP 791 [5]. CAP 791 is the process to notify the CAA of changes at an aerodrome, covering both infrastructure and management system changes.

Some of the key safety requirements and objectives for the IFA 2 facility are formalised as constraints through planning conditions and the legal covenants in the Converter Station Lease and formal agreement of these conditions is a vital part of the assurance evidence.

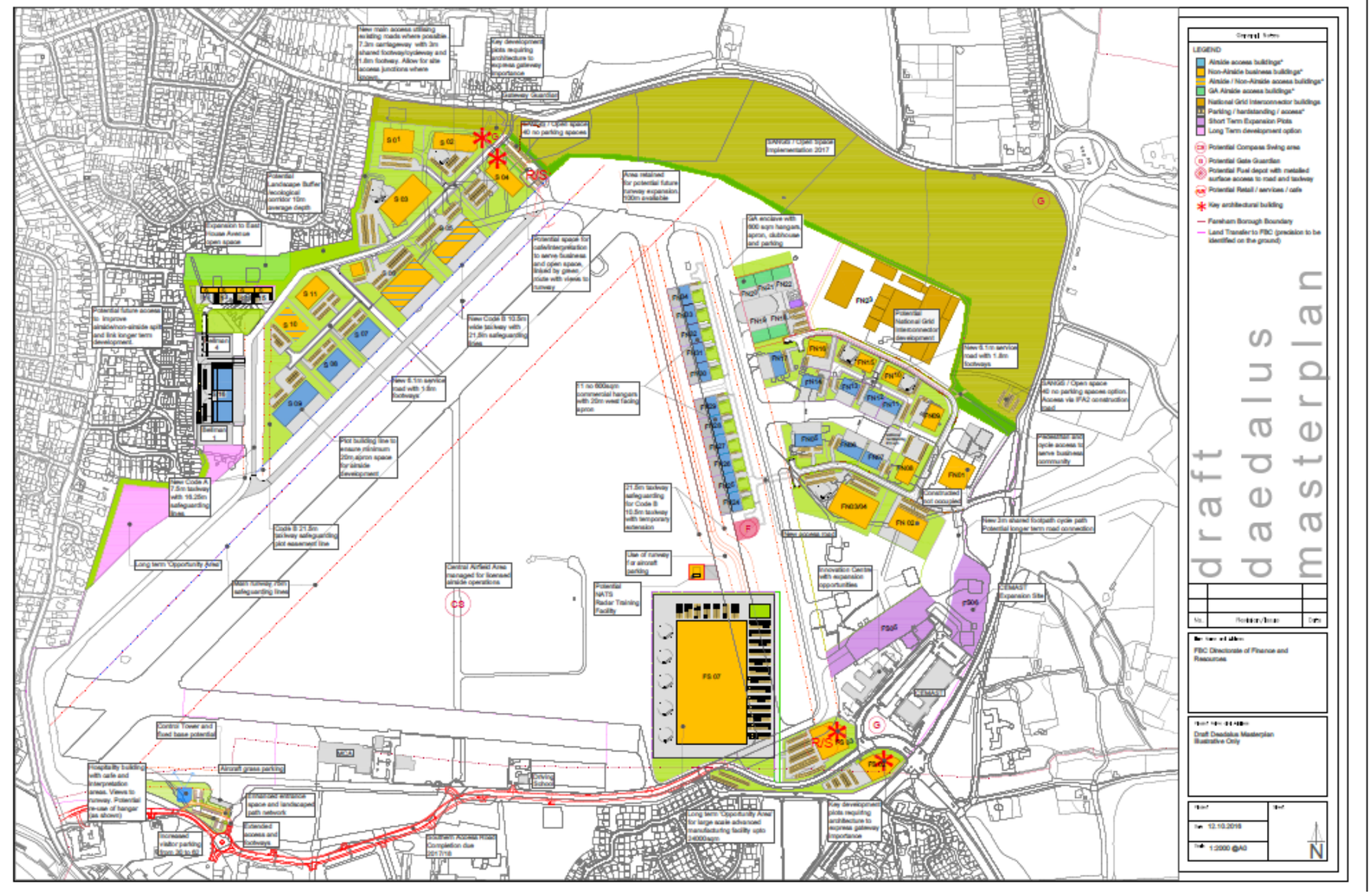
At this stage in the project (part way through the detailed design process), the body of evidence which forms the safety justification for IFA 2 is progressively evolving. As for any major project, the assurance evidence will continue to develop over the project lifecycle. Consistent with the stage in the project lifecycle, a robust base of analysis, calculations and assessment exists which establishes a high level of confidence that safety objectives and safety requirements will be met and that risks related to IFA 2 are acceptable as defined in CAP 760 [4]. Initial testing has been completed simulating the maximum electromagnetic fields that would be generated by the HV DC and AC cables. This has successfully demonstrated the accuracy of the calculations used to generate the EMF analysis and gives confidence that the requirements of planning condition 48 (concerning EMF emissions) will be met. The testing has also validated predictions that effects on aircraft systems are negligible.

The focus of the assurance evidence from this point will be the extensive programme of testing following energisation of the facility to provide the validation evidence for the as-built facility and to demonstrate compliance with planning conditions and requirements from legal agreements.

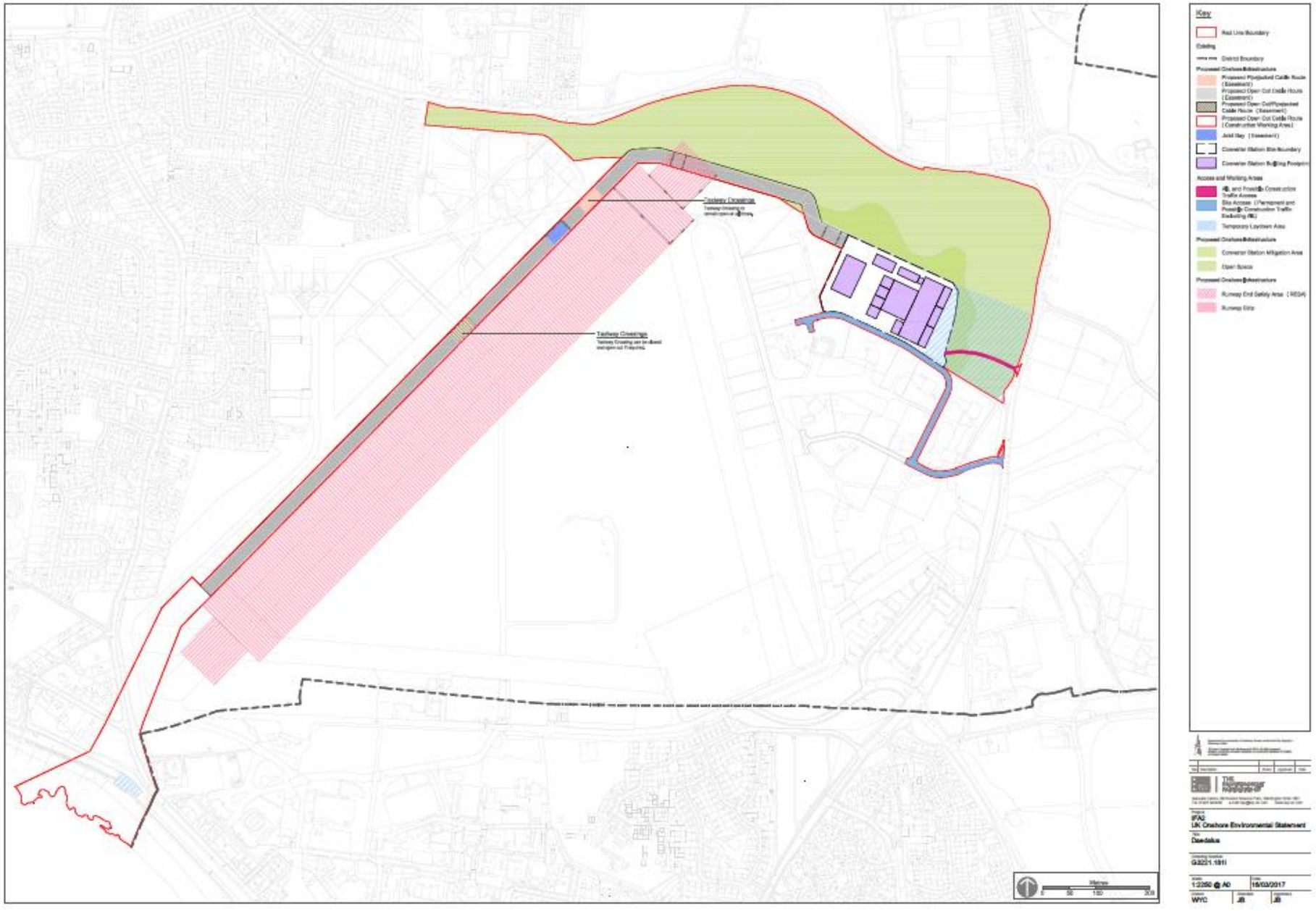
The main conclusions of the safety justification at this stage are as follows:

- Overall, the current state of the evidence available provides a high level of confidence that potential safety risks posed by IFA2 should not adversely impact the airport's current operations or the known planned developments. Once all the dependencies stated in this report are complete, the demonstration that risks posed by IFA2 are acceptable and ALARP as defined in CAP 760 [4] will be complete.
- There are no hazards, risks or issues identified which may place unreasonable or impractical constraints on the design of the IFA 2 Facility.
- The body of assurance evidence available and planned is thorough and diverse, including analysis, calculations and assessment, testing, and simulation. Once complete the extent of the evidence will exceed the minimum requirements in CAP 760 [4] for the confidence level required for validation evidence, based on risk.
- The actions to establish the remaining assurance and thus to complete the body of evidence are recorded in the Hazard Log and captured as "dependencies" in this safety justification.

APPENDIX A SOLENT AIRPORT AND SURROUNDING AREA (THE MASTER PLAN)



APPENDIX B CABLE ROUTE



APPENDIX C SAFETY REQUIREMENTS AND EVIDENCE

ID	Safety Requirement	Minimum Confidence level (for evidence)	Assurance Evidence Available	Dependencies (Further Evidence Required)	Status at issue of this safety justification.
M01	Building lighting to be directed downwards, away from flight paths and control tower, and not towards the runway. This requirement is to be included in the design specifications.	Low	IDE 00034 – IFA2 Converter Station External Flood Lighting (for FBC approval) [25] provides details of external flood lighting, including Lux levels.	M01.1 Confirmation of the final IFA 2 external flood lighting design. M01.2 External security lighting design details to be finalised with confirmation that this meets guidelines for lighting near airports in AOA advice note 2 [32] and BS 5489 'Code of Practice for the Design of Road Lighting [30] as appropriate. M01.3 Final confirmation / agreement that Planning Condition No 10 concerning building external lighting is met.	M01.1 and M01.2 is closed M01.3 Subject to minor documentation clarification then this will be closed.
M02	The design of all road lighting to be compliant with BS 5489 [6] Section 12.2: Lighting in the vicinity of aerodromes.	Low	There are no permanent changes to road / highway lighting around the airport due to IFA2. There will be a temporary roadway constructed for construction traffic, but this will be removed and the area landscaped post construction.	M02.1 Confirmation that there are no road / highway lighting changes related to IFA 2 at final detailed design.	No changes to road lighting so closed.
M03	External surfaces of building to be designed not to present a distraction to aircrew.	Low	IKA-0508- Converter Station Reactor Hall 5 Degree Pitch Option Elevations [26] shows details of building cladding colour (blue / grey) with RAL numbers.	M03.1 Confirmation that the final converter station building cladding design is as per the design specifications.	Cladding specification requires planning approval.
M04	Noise levels to be managed to ensure they are not distracting to pilots, particularly glider pilots.	Low	The noise report (1JNL575900 - Audible Noise - Assessment for Planning Application) [23] has been issued in draft	M04.1 The final version of the noise report -1JNL575900 "Audible Noise - Assessment for Planning Application" [25] to be issued. M04.2 Confirmation that the noise emissions from the IFA 2 facility during operation meet predictions in the noise report [25]. M04.3 Final confirmation / agreement that Planning Condition No 11 and legal agreements concerning noise emissions are met	M04.1 – closed for design. M04.2 and M04.3 - closed for design, requires testing / measurement in operation.
M05	Aircrew and airport ground operators to be kept up-to-date with changes and likely effects.	Low	NOTAMs is standard existing process.	M05.1 RCAM to notify updates on IFA 2 site activities to airport users and tenants through NOTAMs over the construction and operational periods. M05.2 NG has a process in place to provide regular updates on IFA 2 site activities to RCAM over the construction and operational periods.	M05.1, M05.2 – requires ongoing management.
M06	Wind assessment to determine the impact of the building on the wind patterns (including consideration of light aircraft and UAVs).	Low	Wind flow assessment completed confirms no significant impact from IFA 2 on the runway. As now, good airmanship is the means of dealing with localised gusts of wind. Addendum 2 includes further wind assessment including other buildings that may interface with IFA2 i.e, the Faraday Business Park). IKA-0508- Converter Station Reactor Hall 5 Degree Pitch Option Elevations has confirmed the pitched roof design. Addendum 2 to this safety justification concludes that there appear to be no gaps in the analysis and no reasons why IFA2 should be unsafe to UAVs. Wind tunnel testing complete in [40] and results used to provide confidence in the CFD analysis is [39]	None	
M07	Publicity and training to include awareness of changes in landscape in relation to wind effects.	Low	NOTAMs is standard existing process.	M05.1 RCAM to notify updates on IFA 2 site activities to airport users and tenants through NOTAMs over the construction and operational periods. M05.2 NG has a process in place to provide regular updates on IFA 2 site activities to RCAM over the construction and operational periods.	M05.1, M05.2 – requires ongoing management.

ID	Safety Requirement	Minimum Confidence level (for evidence)	Assurance Evidence Available	Dependencies (Further Evidence Required)	Status at issue of this safety justification.
M08	Obstacle clearance surfaces to be protected.	Low	Initial and final airport safeguarding assessment completed in the context of IFA 2 finds not significant issues: Schedule of trees appropriate to the airport issued to landscaping team.	M08.1 Confirmation that choice of trees for landscaping is in accordance with RCAM tree schedule. M08.2 FBC has a process in place to manage vegetation growth	
M09	Effects of wind to be kept under review in the case of increased traffic.	Low	Agreed at FHA that increased traffic has no impact on wind effects.	None	
M10	Airmanship provides mitigation.	Low	As now, good airmanship is the means of dealing with localised gusts of wind.	None	
M11	RCAM to ensure an effective bird management strategy.	Low	Existing bird hazard management process in place and reviewed for IFA 2. Schedule of trees appropriate to the airport issued to landscaping team.	M11.1 RCAM has a Bird Hazard Management process in place updated for IFA 2. M08.1 Confirmation that choice of trees for landscaping is in accordance with RCAM tree schedule. M11.2 RCAM, wildlife experts and planning team agree on plans for water features in the landscaping design in the context of bird hazard management. M08.2 FBC has a process to manage vegetation growth.	M11.1, M08.2 – requires ongoing management. M08.1, M011.2 closed.
M12	Building to provide appropriate access for bird management strategy.	Low	IKA-0508- Converter Station Reactor Hall 5 Degree Pitch Option Elevations [26] has confirmed roof the pitched roof design.	M12.1 Safe means of access to building roof and guttering for clearing bird nests.	To be confirmed in the final design.
M13	The building design to discourage a significant increase in the bird activities or detrimental changes in bird behaviour in this area.	Low	IKA-0508- Converter Station Reactor Hall 5 Degree Pitch Option Elevations [26] has confirmed roof the pitched roof design.	M13.1 Detail of roof, including any bird deterrent / management measures, to be confirmed in the detailed design.	To be confirmed in the final design.
M14	RCAM to discuss bird strikes with a wildlife expert and to seek the expert's advice on how to manage the bird activities in this area.	Low	This is part of M11	None	
M15	FBC to consider the risk of bird strike in future landscaping and choice of trees, and so on.	Low	This is part of M11	None	
M16A	If communication (airport comms) dead spots are found, appropriate procedures are to be put in place to manage the resulting risk.	Low	Confirmed that currently there are no communication blackspots.	M16A.1 FISO radios to be tested prior to IFA 2 and when IFA 2 energised to identify any dead spots. M16A.2 RCAM has procedures in place to manage any radio dead spots identified.	M16A.1 – requires testing. M16A.2 – ongoing management.
M16B	If communication (including TV and digital networks) dead spots are found, appropriate procedures are to be put in place to manage the resulting risk.	Low	Assessments of TV and digital networks to evaluate shadowing effects [18] and [19] has found no significant issues.	M16B.1 Survey carried out prior to IFA 2 and when IFA 2 energised to identify any dead spots affecting emergency services radios.	M16B.1 requires testing in operation.
M17	Planning Constraints to limit permitted noise from IFA2 (taking the proposed runway extension into account).	Low	The planning condition is in place – Planning Condition 10	None	
M18	Airport authority to publicise the start of operations of the IFA2 in advance to airfield users.	Low	Standard existing process for communications.	M18.1 Start of operations advised by RCAM to airfield users through email. M05.2 NG has a process to provide regular updates on site activities to RCAM.	M018.1, M05.2 – requires ongoing management.
M19A	RCAM, in collaboration with NG, to confirm that the magnetic fields at the compass base could not credibly lead	Low	Area defined on the Masterplan [7] and compass survey completed.	M19A.1 Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits.	M19A.1, M19A.2, M19A.3 require testing in operation.

ID	Safety Requirement	Minimum Confidence level (for evidence)	Assurance Evidence Available	Dependencies (Further Evidence Required)	Status at issue of this safety justification.
	to incorrect calibration of magnetic compasses.			M19A.2 Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met. M19A.3 Compass base confirmed as implemented with all signage, airfield markings and instructions in place before IFA 2 is energised.	
M19B	RCAM, in collaboration with NG, to confirm that the magnetic fields at the compass base could not credibly lead to incorrect calibration of magnetic compasses.	Low	As M19A.	None	
M20	Pre-flight check area to be assessed for effect of magnetic fields on the setting of aircraft direction indicators.	Low	The pre-flight check area is a B2 Hold Point currently under consideration.	M19A.1 Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits. M19A.2 Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met. M20.1 Pre-flight check area confirmed as implemented with all signage, airfield markings and instructions in place before IFA 2 is energised.	M19A.1, M19A.2 require testing in operation. M20.1 ongoing – pre-flight check area to be defined.
M21	RCAM to promulgate instruction to calibrate magnetic compasses only at compass base.	Low	As M19A.3 and M20.1	None	
M22	General airmanship provides a mitigation because aircrew should quickly identify incorrect calibration by reference to visual landmarks.	Low	Good airmanship is an existing mitigation employed.	None	
M23	RCAM to promulgate instruction to set DIs against magnetic compasses in designated pre-flight check area.	Low	As M19A.3 and M20.1	None	
M24	FIS procedures to take into account the possibility of impairment of ground-ground communications.	Low	Current procedure in place to phone / radio the tower. Only authorised vehicles are allowed airside.	M24.1 Procedure implemented before FISO introduced that retains the existing rule regarding only authorised vehicles allowed airside.	M018.1, M05.2 – requires ongoing management.
M25	If aircraft using radio altimetry are likely to use the airport, the effect of the IFA2 on radio altimetry is to be assessed.	Low	No aircraft with radio altimetry likely as the equipment is being phased out. General assessments and analysis demonstrating no significant effects from RFI and EMF emissions.	None	
M26	LSA RFI assessment concluded that this is not a credible effect.	Low	Analysis of RFI effects on airport and aircraft systems completed demonstrates no significant effects. No plans to introduce ILS, however generic assessment complete.	M26.1 Testing completed that demonstrates acceptable RFI emissions. M26.2 Final confirmation / agreement that Planning Condition No 14 and legal agreements concerning RFI emissions are met.	M26.1, M26.2 require testing in operation.
M27	Liaise with MCA to identify possible hazards specific to its operation arising from IFA2.	As this relates to a third-party organisation the confidence level is set as high.	Liaison on hazards has taken place with MCA. Assessment of MCA SAR helicopter navigation and flight management systems complete. Agreement reached between NG and MCA concerning MEOSAR / IFA 2 compatibility in the proposed location. Potential adverse effects related to RFI assessed with no significant issues.	M26.1 Testing completed that demonstrates acceptable RFI emissions. M26.2 Final confirmation / agreement that Planning Condition No 14 and legal agreements concerning RFI emissions are met. M19A.1 Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits. M19A.2 Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met.	M26.1, M26.2 require testing in operation. M19A.1, M19A.2 require testing in operation. M27.1 – requires testing.

ID	Safety Requirement	Minimum Confidence level (for evidence)	Assurance Evidence Available	Dependencies (Further Evidence Required)	Status at issue of this safety justification.
				M27.1 FBC impose the requirements for testing by MCA under the legal agreements for MEOSAR and compliance confirmed. This is subject to the FBC and MCA programme and not a constraint on the IFA2 facility.	
M28	Liaison with Britten-Norman to identify possible hazards specific to its operation arising from IFA2.	As this relates to a third-party organisation a pessimistic approach is taken and the confidence level is set as high.	Liaison on hazards has taken place with Britten Norman and representation made to the Planning Committee. Assessment of Islander and Defender aircraft systems electro-magnetic field susceptibility completed, and recommendations raised which are captured in the planning representation.	M28.1 Detailed construction method statement and detailed scheme with cable arrangements in place. M28.2 Monitoring of electro-magnetic fields once operational to confirm that planning conditions are met. M28.3 RCAM submission under CAP 791 "Procedures for Changes to Aerodromes" incorporating IFA 2 and CAA endorsement in place. M19A.1 Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits. M19A.2 Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met.	M28.1, M28.3 – require ongoing management. M28.2, M19A.1, M19A.2 – requires testing in operation.
M29	Liaise with NATS to identify possible hazards specific to its operation arising from IFA2.	As this relates to a third-party organisation a pessimistic approach is taken and the confidence level is set as high.	Liaison on hazards has taken place with NATS. NATS Radar is a training facility and there are no safety risks identified concerning the interface with IFA 2. Agreement reached between NG and NATS concerning radar / IFA 2 compatibility in the proposed location. Potential adverse effects related to RFI assessed with no significant issues.	M26.1 Testing completed that demonstrates acceptable RFI emissions. M26.1 Final confirmation / agreement that Planning Condition No 14 and legal agreements concerning RFI emissions are met. M29.1 FBC impose the requirements for testing by NATS under the legal agreements for radar and compliance confirmed. This is subject to the FBC and NATS programme and not a constraint on the IFA2 facility.	M26.1, M26.2, M29.1 – requires testing in operation.
M30	Detailed surveys for existing services are to be undertaken before excavation of a trench to lay the cables, any existing cables will either be revealed by the survey or exposed on excavation and moved/dealt with appropriately. Thus, subject to this being completed, the risk of electric shock from impressed voltages and touch potentials will be eliminated by design.	High as this risk will be eliminated.	Draft preliminary impressed voltage assessment for cables at Daedalus [29] assesses the risks of impressed voltages on metallic objects and states plans for the mitigation of these risks.	M30.1 Preliminary impressed voltage assessment for cables at Daedalus [29] finalised and plans implemented.	M30.1– detailed design to be finalised.
M31	The communication strategy in place for flying UAVs to be studied further to determine possible risk.	Low	Addendum 2 to this safety justification concludes that there appear to be no gaps in the analysis and no reasons why IFA2 should be unsafe to UAVs.	M31. 1 RCAM has procedures and controls in place for UAVs, before UAVs permitted to fly at Solent Airport. This is not a constraint on IFA2.	M31.1 – requires ongoing management.
M32	Design specifications to require fire protection systems to ensure that fire is controllable.	Low	1JNL439067, C Fire Systems Description [27] provides a description of the fire protection / systems and includes a water deluge system Building cladding confirmed to be non-combustible.	M32.1 Detailed design for the fire protection / suppression systems complete and as per the system description. M32.2 Confirmation that fire protection / suppression system in place is as per the detailed design.	M32.1 – closed for design. M32.2 – requires testing in operation.
M33	Not used				
M34	Lighting signals can be used if RF levels are exceptionally sufficiently high to cause interruption to radio communications systems.	Low	Lighting signals already available for use as they are required by FISO.	M34.1 RCAM has procedures for FISO in place. This is not a constraint on IFA2.	M34.1 – requires ongoing management

ID	Safety Requirement	Minimum Confidence level (for evidence)	Assurance Evidence Available	Dependencies (Further Evidence Required)	Status at issue of this safety justification.
M35	All electrical systems to be designed to ensure RF levels are too low for significant interference.	Low	Analysis of RFI effects on airport and aircraft systems completed demonstrates no significant effects.	M26.1 Testing completed that demonstrates acceptable RFI emissions. M26.1 Final confirmation / agreement that Planning Condition No 14 and legal agreements concerning RFI emissions are met.	M26.1, M26.2 require testing in operation.
M36	Not used.				
M37	A threat assessment to be conducted to determine the threat levels, using input from NG and FBC.	Low	IFA2 assessed as NOT critical infrastructure by NG process.	M37.1 Threat assessment for the Airport updated for IFA2 and measures in place to manage threats as required.	M37.1 – requires ongoing management.
M38	Project documentation to show that AC and direct current (DC) fields comply with requirements.	Low	Analysis of EMF effects completed demonstrates no significant effects.	M19A.1 Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits. M19A.2 Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met.	M19.1, M19.2 require testing in operation.
M39	Review RFI impact on UAVs.	Low	Analysis of RFI effects on airport and aircraft systems completed demonstrates no significant effects. Addendum 2 to this safety justification concludes that there appear to be no gaps in the analysis and no reasons why IFA2 should be unsafe to UAVs.	M26.1 Testing completed that demonstrates acceptable RFI emissions. M26.1 Final confirmation / agreement that Planning Condition No 14 and legal agreements concerning RFI emissions are met.	M26.1, M26.2 require testing in operation.
M40	Any future AGL system to be designed to ensure interference from HV cables cannot credibly affect the lighting.	Low	500-001 - AGL Duct Installation Arrangement and Detail [28] shows ducting installed.	M40.1 The interface between the AGL wiring layout and the HV cable design to be checked for touch potential / impressed voltage hazards and suitable mitigation implemented as necessary.	M40.1 – Design to be checked once available.
M41	The risk of public exposure to electromagnetic fields is eliminated provided the planning constraint for emissions is met.	Low	The Planning constraint limit is ~10uT The accepted limits in UK are the ICNIRP's reference levels [32] which are 500 µT and 10 kV m^{-1} for workers and 100 µT and 5 kV m^{-1} for the public.	M19A.1 Testing completed that demonstrates compliance with electro-magnetic field and compass deviation limits. M19A.2 Final confirmation / agreement that Planning Condition No 48 and legal agreements concerning electro-magnetic fields are met.	M19.1, M19.2 require testing in operation.
M42	The possible effects of heat from the facility on UAVs are to be reviewed.	Low	Addendum 2 to this safety justification concludes that there appear to be no gaps in the analysis and no reasons why IFA2 should be unsafe to UAVs.	None	
M43	Cable protection system to ensure power is promptly removed in the event of an insulation failure.	Low	Draft preliminary impressed voltage assessment for cables at Daedalus [29] assesses the risks of earth potential rises and states plans for the consideration of fault conditions as an interface with the converter station. ABB has plans to produce a safety step and touch voltage study for the converter station.	M30.1. Preliminary impressed voltage assessment for cables at Daedalus [29] finalised and plans implemented. M43.1 Safety step and touch voltage study for the converter building issued and plans implemented.	M30.1, M43.1 – detailed design to be finalised.
M44	The location of the fixed fuel installation and filling points for mobile bowsers is not near the HV cables.	Low	The Masterplan [7] shows the fixed fuel installation is far from the HV cable route. Any changes to the cable route are restricted within red line boundary.	None	

ID	Safety Requirement	Minimum Confidence level (for evidence)	Assurance Evidence Available	Dependencies (Further Evidence Required)	Status at issue of this safety justification.
M45	If any high-power AC cables run parallel or near-parallel to any metal fences or similar structures and run alongside for a significant distance, those structures are to be sufficiently earthed, and that earthing maintained sufficiently, to eliminate the risk of dangerous impressed voltages and touch potentials.	Low	Draft preliminary impressed voltage assessment for cables at Daedalus assesses the risks of earth potential rises and states plans for the consideration of fault conditions as an interface with the converter station. ABB has plans to produce a safety step and touch voltage study for the converter station.	M30.1. Preliminary impressed voltage assessment for cables at Daedalus [29] finalised and plans implemented. M43.1 Safety step and touch voltage study for the converter building issued and plans implemented.	M30.1, M43.1 – detailed design to be finalised.

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