OSPREY
CONSULTING SERVICES
a tpgroup company

London Biggin Hill Airport RWY21 RNAV(GNSS) IAP

Safety Case Report Part 1

Date: 16th March 2022
Revision: Issue 2
Osprey Ref: 71372 014

The Hub, Fowler Avenue, Farnborough Business Park, Farnborough, GU14 7JP
01420 520200 / enquiries@ospreycsl.co.uk
Registered in England and Wales under No: 06034579

Document Details

Reference	Description
Document Title	London Biggin Hill Airport RWY21 RNAV(GNSS) IAP
	Safety Case Report Part 1 – Safety Requirements
Document Ref	71372 014
Issue	Issue 2
Date	16th March 2022
Client Name	London Biggin Hill Airport

Issue	Amendment	Date
Issue 1	Initial Release	26th May 2021
Issue 2	Updated after HazID for procedures including an RNAV to ILS element. Also removes design options that have been discounted and any related hazards.	16th March 2022

Executive Summary

London Biggin Hill Airport (LBHA) is seeking to undertake an airspace change in order to update the means of navigation used by aircraft, in line with the overall United Kingdom airspace modernisation.

LBHA is proposing to introduce an Area Navigation (RNAV) (Global Navigation Satellite System (GNSS)) Instrument Approach Procedure (IAP), with Lateral Navigation and Vertical Guidance Minima to Runway 21 (RWY21).

Both LBHA and the Civil Aviation Authority (CAA) Safety and Airspace Regulation Group (SARG) require assurance that the introduction of the RWY21 RNAV(GNSS) IAP at LBHA will result in safe air operations at all stages of its implementation lifecycle. The form of this assurance is an operationally focused Safety Case, structured in four parts as recommended by the LBHA Management Manual [Ref. 01].

This document is the Safety Case Report Part 1 for the new RWY21 RNAV(GNSS) IAP being introduced at LBHA. The Safety Case Part 1 sets out the Safety Requirements that must be satisfied to ensure that the use of the proposed RWY21 RNAV(GNSS) IAP at LBHA will be acceptably safe when introduced into operational use and throughout its in-service usage.

Table of Contents

Table of Tables

1 Introduction

1.1 General

London Biggin Hill Airport (LBHA) is seeking to undertake an airspace change in order to update the means of navigation used by aircraft, in line with the overall United Kingdom (UK) airspace modernisation.

LBHA is proposing to introduce an Area Navigation (RNAV) (Global Navigation Satellite System (GNSS)) Instrument Approach Procedure (IAP), to Runway 21 (RWY21).

1.2 Purpose

LBHA and the Civil Aviation Authority (CAA) Safety and Airspace Regulation Group (SARG) require assurance that the introduction of the RWY21 RNAV(GNSS) IAP at LBHA will result in safe air operations at all stages of its implementation lifecycle.

The form of this assurance is an operationally focused Safety Case, structured in four parts as recommended by the LBHA Management Manual (MM) [Ref. 01].

This document is the Part 1 of the Safety Case for the new RWY21 RNAV(GNSS) IAP being introduced at LBHA. The purpose of this Safety Case Report Part 1 is to set out the Safety Requirements that must be satisfied to ensure that the use of the proposed RWY21 RNAV(GNSS) IAP at LBHA will be acceptably safe when introduced into operational use and throughout its in-service usage.

1.3 Scope

The scope of this document, and the activities described within, focuses on the delivery of the RWY21 RNAV(GNSS) IAP at LBHA. However, it is imperative that the safety requirements are set with due reference and consideration to the complete end-to-end Air Traffic Service (ATS) provided by LBHA and the airspace stakeholders whom it may influence.

1.4 Document Structure

This Safety Case is structured in six sections, and four annexes, as outlined below:

- Section 1 – Introduction
- Section 2 – LBHA Operational Context
- Section 3 – Safety Argument
- Section 4 – Safety Case Part 1: Safety Requirements
- Section 5 – References
- Section 6 – Glossary
- Annex A1 – Current airspace in the vicinity of LBHA
- Annex A2 – LBHA RWY21 RNAV(GNSS) IAP Options
- Annex A3 – Risk Tolerability Criteria
- Annex A4 –Risk Assessment Summary

2 LBHA Operational Context

2.1 Overview

LBHA is a regional airport located approximately 12nm south-south east of London.

It services the Business sector of the General Aviation domain with regular short to long-haul corporate passenger services, as well as occasional charter and cargo flights.

The Airport operates a strict Prior Permission Required (PPR) policy. The published aerodrome opening hours are (UTC):

- Winter: Mon-Fri 0630-2300; Sat/Sun/PH 0800-2200
- Summer: Mon-Fri 0530-2200; Sat/Sun/PH 0700-2100
- Outside published opening hours by arrangement.

Note: While the focus of this document is RWY21, some details regarding RWY03 are listed for context.

2.2 Runway Characteristics

2.2.1 Physical Characteristics

The runway at LBHA is orientated 03/21, with RWY 03 categorised as a Code 4C visual runway and RWY21 categorised as Code 4C instrument runway in accordance with the requirements of CAP 168 [Ref. 02].

The declared distances for runway 03/21 are shown in Table 1.

RWY	Take-off Run Available (TORA)	Take-off Distance Available (TODA)	Accelerate Stop Distance Available (ASDA)	Landing Distance Available (LDA)
03	1778 m	2175 m	1781 m	1555 m
21	1670 m	1804 m	1670 m	1670 m

Table 1: LBHA Runway Declared Distances

2.2.2 Runway Visual Aids

RWY21 has the following markings:

- Runway threshold
- Runway designator
- Runway centreline
- Runway touchdown zone
- Runway fixed distance markers

Specific characteristics associated with the LBHA RWY21 Aeronautical Ground Lighting (AGL) are as follows:

- Precision Approach Path Indicator (PAPI) are provided for RWY21 on left hand side of runway, 3-degree angle, 231 metres from threshold.
- Runway lighting is provided for RWY21 as follows:
    - White edge lights: elevated hi-intensity, bi-directional with a low intensity omni-directional component.
    - Threshold: green bars.
    - Red stop end lights
    - Green centreline reflectors at exit points.
- Approach lighting: white high intensity centreline for a distance of 420m with three crossbars.
- There is no aerodrome beacon at LBHA.

2.3 Communications

The following VHF frequencies have been allocated for the two Air Traffic Control (ATC) functions provided at LBHA:

- 129.405MHz "Biggin Approach" (25nm/10,000ft)
- 134.805MHz "Biggin Tower" (25nm/4,000ft)

Both frequencies are served by main and standby transmitters. The switching facilities available to the controller are through a touchscreen Voice Communications and Control System (VCCS).

The following frequencies are also available to ATC.

- 135.680MHz "Biggin Hill Information" (ATIS) (60nm/20,000ft)
- 121.600MHz "Biggin Approach" (25nm/4,000ft) *(Note: Frequency 121.600MHz is available to an aircraft in an emergency subject to coordination with the Distress and Diversion (D&D) cell at The London Terminal Control Centre (LTCC)).*

A UHF frequency is provided for the control of vehicles and personnel on the manoeuvring area.

2.4 Navigational Aids

2.4.1 ILS/DME

RWY21 at LBHA is equipped with a Category I Instrument Landing System (ILS) with associated Distance Measuring Equipment (DME). The equipment details are as follows:

- Localiser: Indra Navia NM7014B Dual TX, Dual Frequency
- Localiser Antenna: Indra Navia NM 7212A 12 Element
- Glidepath: Indra Navia NM 7033B Dual TX, Dual Frequency
- Glidepath Antenna: Indra Navia NM 3545 M Array
- DME: INDRA LDB-103.

There is no ILS for RWY 03.

2.4.2 VOR

The VHF Omnidirectional Range (VOR) facility is used at LBHA as an approach aid. The VOR is owned and maintained by NATS, however it is due to be removed from service in the near future, as directed by NATS (1 December 2022).

2.4.3 Direction Finding (DRDF)

A Fernau Avionics Dual Channel Doppler Radio Direction Finder (DRDF)/VHF Direction Finder (VDF) is supplied for use by the Aerodrome and Approach controllers.

The VDF must not be used as an Approach aid. No published procedure exists.

2.5 Surveillance

Thames Radar provides an Approach Surveillance Service to LBHA Instrument Flight Rules (IFR) traffic requiring a surveillance service. LBHA Approach co-ordinates all IFR traffic wishing to operate in controlled airspace (CAS) with Thames Radar.

LBHA has no local surveillance capability; surveillance data is provided by NATS through Thames Radar for use with an Aerodrome Traffic Monitor (ATM). The ATM is an Indra Nova 9000 with 2 Controller Working Positions (CWP) located in the VCR.

The ATM assists controllers at LBHA in achieving maximum runway utilisation and may be used by the Aerodrome Controller for:

- Determining the landing order, spacing and distance from touchdown of arriving aircraft.
- Assisting in applying longitudinal separation for departing aircraft.
- Confirming that the initial track of a departing aircraft conforms with the clearance issued.
- Providing information to aircraft on the position of other aircraft in the circuit or carrying out an instrument approach.

As of July 2021, LBHA will be able to use advanced ATM and be used to:

- Following identification, validate SSR codes of departing aircraft and verify associated Mode C read-outs.
- Monitor the progress of overflying aircraft identified by Approach Radar Control to ensure that they do not conflict with the tracks of arriving or departing aircraft.
- Establish separation between departing aircraft.
- Pass traffic information.
- Establish separation in the event of a missed approach.
- Assist in taking initial corrective action when the separation between arriving aircraft becomes less than the prescribed minima.

2.6 Air Traffic Services

Aerodrome and Approach Control functions are provided at LBHA.

Aerodrome Control is responsible for Ground Control, Tower Control, and Clearance Delivery. Aerodrome Control co-ordinates with Approach Control for:

- Departing IFR flights.
- Departing Visual Flight Rules (VFR) flights.
- Arriving aircraft which make their first call on the Tower frequency (unless they are transferred to Approach Control).

LBHA Approach Control provides the following ATS, in accordance with the LBHA Manual Air Traffic Services (MATS) Part 2 [Ref. 03]:

- Procedural Service (only available to IFR aircraft);
- Basic Service.
- Alerting Service.

NATS Ltd through Terminal Control (TC) Thames Radar, are contracted to provide radar services to IFR flights arriving or departing from LBHA, regardless of the service requested by the pilot.

Before any IFR flight departs, or immediately an inbound or transit IFR flight contacts LBHA Approach, co-ordination must be affected with TC Thames Radar regardless of type of service being provided.

There are currently three IAPs published in the UK Aeronautical Information Publication (AIP) for RWY21.

- RWY21 ILS/DME/VOR IAP (AD 2-EGKB-8-1)
- RWY21 LOC/DME/VOR IAP (AD 2-EGKB-8-2)
- RWY21 VOR/DME. (AD 2-EGKB-8-3)

2.7 Airspace Environment

2.7.1 General

LBHA is situated in Class G, uncontrolled airspace; however, it has an Aerodrome Traffic Zone (ATZ), of radius 2.5 NM centred on runway 03/21. The ATZ is established to protect the airport's operations and all en-route traffic is required to avoid it unless permission has been granted to enter by LBHA.

The ATZ extends from surface to 2,000 ft above airfield level (aal). London Terminal Control (Swanwick) is the controlling authority for that part of the ATZ (that penetrates the overlying CAS Class A) from 1,900 ft aal to 2,000 ft aal.

The airspace above LBHA (2,500ft +above mean sea level (amsl)) is categorised as Class A airspace within the London Terminal Control Area (LTMA).

LBHA is also in close proximity to London City Airport (LCY) Control Area (CTA) and London Gatwick Airport (LGW) CTA.

The airspace in the vicinity of LBHA is shown in Annex A1.

2.7.2 Redhill Aerodrome

Redhill aerodrome is located approximately 10NM southwest of LBHA (beneath the Gatwick CTA) and the Redhill ATZ (2NM radius) extends beyond the northern boundary of the Gatwick CTA. It is a licensed grass airstrip operating between 0900-1700 in summer and 0800-1800 local in winter.

The southern half of Redhill aerodrome lies within the Gatwick Control Zone (CTR) and the northern half lies beneath the Gatwick CTA. During the hours of watch of Redhill ATC, subject to the restrictions listed below, flights without reference to Gatwick ATC may be made within the Redhill Local Flying Area (LFA), as published in the Redhill UK AIP entry.

- Aircraft are to remain clear of cloud and with the surface in sight.
- Maximum altitude — 1500 ft QNH.
- Weather minima: Minimum meteorological visibility 5000 M and/or cloud ceiling 1500 ft.

Entry/exit routes and associated Visual Reference Points (VRPs) for aircraft inbound to/outbound from Redhill are established to the north of the aerodrome at the M25/M23 Junction (Junction 7) and at Godstone. Departing a/c should maintain 1,400 ft until past a particular VRP, and that arriving aircraft shall join at 1,400 ft.

All aircraft using Redhill must have a serviceable transponder.

2.7.3 RAF Kenley

RAF Kenley is an aerodrome located approximately 5NM west south-west of LBHA. It is used by Surry Hills Gliding Club Monday to Friday and 615 Volunteer Gliding Squadron (VGS) at weekends.

Although there is no ATZ established at Royal Air Force (RAF) Kenley, the area is marked on the VFR chart as an area of "Intense Glider Activity".

Gliders from RAF Kenley are able to operate south of RAF Kenley towards the M25.

2.8 Proposed IAP – RWY21

2.8.1 Overview

A description of each IAP Design Option is provided in the Design Options Development report [Ref. 09].

2.8.2 Lateral Options

The Design Principles, and additional feedback from CAP 1616 Stage 1, suggested the desire to keep arrival aircraft within the current vectoring swathe. This aligns with the constraints of the existing air traffic arrangements.

The following Lateral Options were considered:

- Option 1 – Do Nothing.
- Option 2 – Replica of the current VOR/DME approach which starts from ALKIN.
- Option 3 – Lateral left of current VOR plate, starting from ALKIN remaining within current ILS vectoring swathe.
- Option 4 – Lateral right of current VOR plate, starting from ALKIN remaining within current ILS vectoring swathe.
- Option 5 – From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing through the centre of the current ILS vectoring swathe.

- Option 6 – From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing down the left of the current ILS vectoring swathe.
- Option 7 – From OSVEV and ignoring ALKIN, to enable inbounds to exit the network, routing down the right of the current ILS vectoring swathe.

Additional categorisation

- T: Utilises a T-bar lateral approach philosophy where aircraft join from either the right- or left-hand side (making a T on the map) of the approach.
- D: Utilises a direct routing between OSVEV and ALKIN.

2.8.3 Vertical Options

The Design Principles, and additional feedback from CAP1616 Stage 1, suggested that due to environmental concerns aircraft should be kept higher for longer. This project is only concerned with aircraft from 3,000ft due to the extant airspace structure, so this element was investigated as higher final approach.

The vertical options considered were as follows:

- Option A: 3° Glideslope – the industry standard and the current approach angle for the VOR/DME and the ILS on Runway 21.
- Option B: 3.2° Glideslope – The procedures at Heathrow show that this approach can be flown successfully alongside a 3° ILS and that a small noise reduction is achievable and measurable if monitors are sited in an array under and close to the approach.
- Option C: 3.5° Glideslope – the work undertaken by LBHA on the ACP for an RNAV approach to Runway 03 proves that the operators at LBHA can successfully operate with a glideslope at 3.5°. This option requires both the RNAV and the ILS glideslope to be 3.5° to achieve a safe final approach environment. While the FAF is likely to move marginally, the current radar vectoring is not expected to change. This will result in ALL IFR inbounds being higher for longer. As this will in part, be facilitated by an RNAV to ILS approach there is no temperature impact to compromise availability.

2.8.4 Missed Approach Procedure

Option 8 - do nothing. This is only possible with Option 1. Any change from the VOR/DME procedure will necessitate a different MAP.

Option 9, 10 and 11 utilise ALKIN as the Missed Approach Procedure (MAP) hold (although the construct of the hold will change with the RNAV(GNSS) design requirements). The constraints of this project negate the construction of a hold anywhere else due to the knock-on effect to other procedures and airspace users.

An addition option (Option 12) was included after the Aviation Focus Group [Ref. 05], shown in Annex A2. It was not developed to PANS-OPS requirements, and it was only a rough guide to depict stakeholder proposed design option.

3 Safety Argument

3.1 Top Level Safety Claim

The overarching, top-level Safety Claim (Claim 0) is that the use of the new RWY21 RNAV(GNSS) IAP at LBHA will be acceptably safe when introduced into operational use and throughout their in-service usage.

In the context of this Project, 'acceptably safe' means a Risk Classification that is either:

- **Acceptable**: Risk is considered acceptable but should be reviewed if it reoccurs or changes that affect the risk are made. Acceptable risks may be signed off by the Safety Manager, Head of Department (listed in Review), the Operations Director or the Accountable Manager.
- **Review**: The level of risk is of concern and mitigation measures are required to reduce the level of risk to as low as reasonably practicable. Where further risk reduction/mitigation is not practical or viable, the risk may be accepted, provided that the risk is understood and has the endorsement of the Accountable Manager or Head of Department (SATCO, SAFO, Operations Director, Head of Airport Operations, Head of Fixed Base Operations, CFO, BDD).

The above terms are as defined in the LBHA MM [Ref. 01].

In order to demonstrate Claim 0 is valid, it is necessary to support it with two subsidiary claims, namely:

- Claim 1: The extant operation at LBHA is acceptably safe.
- Claim 2: The use of the RWY21 RNAV(GNSS) IAP at LBHA will be acceptable safe.

The underpinning Arguments and Evidence are developed in the following paragraphs.

3.2 Claim 1 Context

Claim 1 represents the current operational situation at LBHA and establishes the baseline against which all further claims are substantiated. It demonstrates that the in-use Concept of Operations is acceptably safe and that any local issues are understood; importantly it makes no statement about assuring future safety. This is necessary to show there are no inherent issues with the current operation at LBHA that may ultimately prejudice the safety of the RWY21 RNAV(GNSS) IAP implementation.

Ref	Argument	Evidence	Rationale
1.1	LBHA is an Aerodrome Licensed by CAA	LBHA holds a current Ordinary Aerodrome Licence (Number UKNEGKB-001). Aerodrome is therefore subject to regular audit by the CAA.	CAA has statutory responsibility to regulate ATS safety within the UK under the Air Navigation Order.
1.2	Safety is proactively managed	Safety related ATS procedures are set out in the LBHA Aerodrome Manual [Ref. 06], LBHA MATS Part 2 [Ref. 03] and LBHA MM [Ref. 01].	Adherence to proven procedures can reduce likelihood of an incident. Effective safety oversight can correct reductions in safety before an incident can occur.
1.3	The current ATS achieves a tolerable level of service level incidents.	Mandatory Occurrence Reports (MORs) and Airfield and ATC Occurrence Reporting are detailed in the LBHA Aerodrome Manual [Ref. 06], Section 3, Chapter 10 "Occurrence Reporting". Analysis of UK Airprox reports has revealed no trend in incidents involving LBHA aircraft.	Any significant deficiencies are likely to be detected.

Table 2: Argument and Evidence supporting Claim 1 of Safety Argument

3.3 Claim 2 Context

The design and implementation of the RWY21 RNAV(GNSS) IAP will require that any change from the current operational characteristics and aviation environment is identified, as must the practises and procedures that manage any safety risk arising from the change. This includes any change in the interaction with other interested parties, e.g. other airspace users and adjacent airports.

It is imperative that the transition into use of the RWY21 RNAV(GNSS) IAP is subjected to a managed process that ensures all the safety claims relating to the ATS remain valid from the point of first use and throughout operational lifetime of the IAP, including the assurance that all external Stakeholders are prepared for the revised operational environment.

Claim 2 is supported by four sub-claims:

- Claim 2.1: All hazards pertaining to the introduction and use of the RWY21 RNAV(GNSS) IAP have been identified and understood, including those associated with other airspace users, adjacent airports and aviation organisations.

- Claim 2.2: The submitted design for the RWY21 RNAV(GNSS) IAP is deemed acceptably safe and agreed by the CAA.
- Claim 2.3: The Programme for transitioning the RWY21 RNAV(GNSS) IAP into operational use is planned and acceptably safe.
- Claim 2.4: The use of the RWY21 RNAV(GNSS) IAP will remain acceptably safe during use.

The intended approach for satisfying these Claims is set out in the following sections.

3.4 Claim 2.1 – Introduction and Use

All hazards pertaining to the introduction and use of the RWY21 RNAV(GNSS) IAP have been identified and understood, including those involving other airspace users, adjacent airports and aviation organisations.

Ref	Argument	Evidence	Rationale
2.1.1	All credible functional hazards and mitigations have been identified.	Hazard Identification (HazID) involving all key Stakeholders and based upon the proposed RWY21 RNAV(GNSS) IAP in the context of LBHA airspace is described in the Safety Case Part 1 (Section 4.1 of this Safety Case Report). Record of HazID – Recorded in [Ref. 07].	HazID conducted with suitably qualified personnel involving all key Stakeholders. Hazard gathering should therefore be comprehensive.
2.1.2	Safety Requirements have been specified that reduce the risks associated with the hazards to a level that is Acceptable and/or Review (in accordance with the LBHA MM [Ref. 01])	Safety Requirements are specified in the Safety Case Part 1 (Section 4.2 of this Safety Case Report), as an output of the HazID.	Any mitigations, control measures or assumptions identified during the HazID are captured as Safety Requirements, such that they can be managed appropriately.

Table 3: Argument and Evidence supporting Claim 2.1 of Safety Argument

3.5 Claim 2.2 – Design

The submitted design for the RWY21 RNAV(GNSS) IAP is deemed acceptably safe and agreed by the CAA.

This section will be developed in the Safety Case Part 2.

3.6 Claim 2.3 – Transition

The Programme for transitioning the RWY21 RNAV(GNSS) IAP into operational use is planned and acceptably safe.

This section will be developed in the Safety Case Part 3.

3.7 Claim 2.4 – In Operation

The use of the RWY21 RNAV(GNSS) IAP will remain acceptably safe during use.

This section will be developed in the Safety Case Part 4.

4 Safety Case Part 1 – Safety Requirements

4.1 Hazard Identification

4.1.1 Initial HazID

An initial HazID meeting (HazID-1) was held on the 21st April 2021 and it was based upon the guidance provided in the HazID Briefing Pack [Ref. 08]. The HazID drew upon the knowledge and experience of a team of Subject Matter Expert and consisted of a 'structured brainstorming' hazard identification process.

Note that RWY21 RNAV(GNSS) IAP Option 3 and Option 4 were not assessed during the HazID workshop as they were already discontinued as it proved impossible to design as stated in the Stage 2 Design Options Development Document [Ref. 09].

The aims of the HazID were:

- To identify the hazards associated with the proposed implementation of the RWY21 RNAV(GNSS) IAP at LBHA.
- To investigate the causes of the identified hazards.
- To identify potential consequences (incidents/accidents) which may arise from the identified hazards.
- To investigate potential mitigations/controls that will prevent the identified hazards occurring or limit the consequences.

A detailed record of the HazID process is contained in the HazID Record [Ref. 07] which provides a detailed description of the HazID methodology, the HazID attendees and the HazID results.

4.1.2 RNAV to ILS element HazID

Since HazID-1, it has been proposed to introduce an RNAV to ILS element to the design options. This will remove the reliance on EGNOS (being lost as a result of BREXIT) and the VOR that is being withdrawn from service. Furthermore, it will reduce the workload of Thames Radar who ordinarily provide radar vectors to the ILS.

Additionally, the RWY21 IAP design options have been refined since HazID-1, to the following:

- Option 2A
- Option 2AD
- Option 9 (MAP)

A second HazID (HazID-2) was held on 7th February 2022 to consider the RNAV to ILS elements of the above options. The results of HazID-2 are recorded in [Ref. 17].

4.1.3 HAZID Assumptions

Both the HazID exercises were conducted with the following assumptions:

- Current operations at LBHA maintain a tolerable level of safety.
- Provision of an ATS at LBHA is by competent, trained personnel.
- Aircraft will be flown and operated by competent, trained personnel.
- As of July 2021, LBHA will be able to use advanced ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10].
- LBHA opening hours match those of Thames Radar service.

4.1.4 HazID Result Summary

HazID-1 identified 19 hazards associated with the proposed implementation of RWY21 RNAV(GNSS) IAP design options at LBHA, as detailed in the HazID Record [Ref. 07] .

Due to the timing of HazID-2 some options were not discussed since they had been discontinued through the CAP 1616 process. A further 5 hazards were identified at HazID-2, specifically associated with the RNAV to ILS elements of the design options [Ref. 17].

A consolidated list of identified hazards is presented in Table 2.

Those hazards associated with design options that have since been rejected (through the CAP1616 process – see [Ref. 11]) are not shown.

Haz No.	Hazards	Option Applicability	Description
HAZ 01	Loss of Navigational Information	All	Aircraft cannot fly the published procedure.
HAZ 02	Corruption of Navigational Information	All	Aircraft does not accurately fly the published procedure.
HAZ 03	Loss/Corruption of Voice Communication (Air-Ground)	All	LBHA ATC is unable to pass information to aircraft. Pilots are unable to communicate with ground stations.
HAZ 04	Loss/Corruption of Ground Comms to Other Aerodromes/ Agencies	All	Controllers unable to coordinate to ensure safe separation between mixed arrivals and departures.
HAZ 05	Loss of Thames Radar surveillance	All	Aircraft operating in CAS without appropriate monitoring – controller unable to provide standard separation.
HAZ 06	Corruption of Thames Radar surveillance	All	Aircraft operating in CAS without appropriate monitoring – controller unable to provide standard separation.

Haz No.	Hazards	Option Applicability	Description
HAZ 07	Multiple aircraft using the IAP at any one time.	All	Multiple aircraft may use the IAP at any one time. Differing speeds could result in loss of required separation
HAZ 08	No radar vectors provided between OSVEV and ALKIN	Option 2A/2AD	Radar vectors cannot be provided between the end of the transition approach (OSVEV) and start of the RWY21 RNAV(GNSS) IAP (ALKIN) in the event of communication failure or NATS unavailable.
HAZ 09	*Hazard related to design option that has been rejected*		
HAZ 10	*Hazard related to design option that has been rejected*		
HAZ 11	*Hazard related to design option that has been rejected*		
HAZ 12	*Hazard related to design option that has been rejected*		
HAZ 13	MAP conflicts with gliders flying at Kenley airfield.	Option 9	Conflict in Class G airspace
HAZ 14	Increased Flight Crew workload	Option 9	Multiple actions are required by the flight crew to perform the MAP.
HAZ 15	*Hazard related to design option that has been rejected*		
HAZ 16	*Hazard related to design option that has been rejected*		
HAZ 17	*Hazard related to design option that has been rejected*		
HAZ 18	*Hazard related to design option that has been rejected*		
HAZ (I)01	Switch to ILS from RNAV	Option 2A/2AD	Switch to ILS from RNAV adds to an already high cockpit workload situation
HAZ (I)02	Switch from RNAV to ILS is not made	Option 2A/2AD	Aircraft does not fly the published procedure
HAZ (I)03	Aircraft does not establish on ILS	Option 2A/2AD	Aircraft systems do not capture the ILS beam
HAZ (I)04	Switching from ILS to RNAV (in the case of a MAP)	Option 9	Switch to RNAV from ILS adds to an already high cockpit workload situation

Haz No.	Hazards	Option Applicability	Description
HAZ (I)05	Loss of GNSS	Option 2A/2AD Option 9	Aircraft cannot fly the published procedure

Table 4: List of Identified Hazards

4.1.5 Post-HazID Design Activities

In accordance with CAP 1616, as presented in the Design Principles Evaluation Document [Ref. 11], each of the options were assessed as ACCEPT or REJECT.

At this step of the process options were marked as REJECT only when the Safety Design Principle (DP1) was not met (DP1: new routes must Be safe and not erode current ANSP safety barriers). The outcome of the HazID workshop was used to evaluated whether options meet the DP1.

The following options are progressing into the next step as future route possibilities:

- Option 2A
- Option 2AD
- Option 9

Consequently, this Safety Case Part 1 will only focus on the hazards applicable to these options. Full analysis of the hazards assesses is presented in Annex A4.

4.2 Derivation of Safety Objectives and Requirements

4.2.1 Overview

The LBHA MM [Ref. 01] Severity Classification Scheme, Probability classifications and Risk Tolerability matrix, presented in Annex A3, have been used for the derivation of Safety Requirements.

It is not practical to derive numerical Safety Objectives for the design of the LBHA RWY21 RNAV(GNSS) IAP design options due to the many unpredictable and unquantifiable factors in the operational environment, not least the inherent nature of Class G airspace and the use of that airspace. Any mitigation that is proposed to manage the risks presented by the hazards are identified as Safety Requirements and linked to the Hazard.

Detail on how the Safety Requirements were derived is provided in the following sections and is summarised in Annex A4.

4.2.2 Analysis of Hazard HAZ 01 (All options)

HAZ 01 Loss of Navigational Information: *Aircraft cannot fly the published procedure, due to failure of the GNSS, Flight Management System (FMS) failure or Human error (flight crew).*

This hazard relates to a loss of navigational information, whereby an aircraft flying the LBHA RWY21 RNAV(GNSS) IAP experiences a loss of navigational data.

The possible causes of HAZ 01 are equipment and human based:

- Loss of GNSS data.
- Failure of aircraft navigational equipment (e.g., FMS).
- Human error (Flight Crew).

HAZ 01 will result in the inability of the aircraft to fly the IAP; however, the flight crew could revert to contingency navigation equipment or ask for ATC assistance. In the worst-case scenario HAZ 01 may result in Controlled Flight into Terrain (CFIT) or Mid-Air Collision (MAC).

In the case of a MAP, then it could result in an incursion of the Gatwick CTA.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as CATASTROPHIC.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of inherent mitigations exist that limit the likelihood of such a consequence of loss of navigational data.

- The loss of navigational data is likely to be detected, since navigational systems will fail to function, and the loss will be enunciated via a Receiver Autonomous Integrity Monitoring (RAIM) Alert.
- The flight crew will be in two-way voice communications with either Thames Radar (when in CAS) or LBHA ATC, and so can respond to ATC instructions accordingly.
- If still within CAS, Thames Radar can provide radar vectors.
- There are alternative IAPs at LBHA that use terrestrial navigational aids. If appropriate (with consideration to meteorological conditions) the flight crew can perform a conventional IAP to RWY 21.
- If necessary, a diversion can be made to another aerodrome.
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.

Further, in respect of a MAP:

- LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] ***(SR10)***.
- Gatwick Airport ATC will detect potential infringing aircraft through the Controlled Airspace Infringement Tool (CAIT).

Successful use of the RWY21 RNAV(GNSS) IAP is reliant upon the GNSS providing the assurance, credibility and confidence that the SiS continues to meet the requirements listed in International Civil Aviation Organization (ICAO) Annex 10 Volume 1 Radio Navigation Aids [Ref. 12], table 3.7.2.4-1 to be able to support Approach with Vertical Guidance (APV) operations (replicated in Table 5).

Typical operation	Accuracy horizontal 95%	Accuracy vertical 95%	Integrity	Time-to-alert	Continuity	Availability
ICAO (APV-I) Performance Requirement	16.0 m (52 ft)	20 m (66 ft)	$1–2 \times 10^{-7}$ in any approach	10 s	$1–8 \times 10^{-6}$ per 15 s	0.99 to 0.99999

Table 5: ICAO Annex 10 APV-I Performance Requirements

It is therefore argued that the likelihood of a loss of all navigational data is limited by compliance with the following Safety Requirement:

- Compliance with the ICAO Safety Objectives (detailed in Table 5) demonstrates that the likelihood of a loss of GNSS Data is low ***(SR01)****: The integrity and accuracy of the navigation aids used for instrument approaches are such that they will provide the crew of participating aircraft with sufficiently reliable and accurate guidance to enable them to follow the published IAP within the tolerable limits required to avoid flight into terrain or obstacles*.

Given the mitigating factors and the above derived Safety Requirement, it is argued that the likelihood of a loss of all navigational data resulting in a CATASTROPHIC event is EXTREMELY IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.3 Analysis of Hazard HAZ 02 (All options)

HAZ 02 Corruption of Navigational Information: *Aircraft does not accurately fly the published procedure, due to GNSS SiS integrity failure, FMS failure or Human error (flight crew).*

This hazard relates to corruption of navigational information, whereby an aircraft flying the LBHA RWY21 RNAV(GNSS) IAP fails to follow the published procedure due to incorrect navigation data.

The possible causes of HAZ 02 are equipment and human based:

- Corruption of GNSS data.
- Malfunction of aircraft navigational equipment (e.g., FMS).
- Human error (Flight Crew).

The worst-case consequence of HAZ 02 could be CFIT or MAC.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as CATASTROPHIC.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of inherent mitigations exist that limit the likelihood of such a consequence of corruption of navigational data.

- The corruption of navigational data may be detected, since a GNSS integrity error will be enunciated via a RAIM Alert. However, malfunctioning of the FMS may go undetected.
- If still within CAS, Thames Radar can provide radar vectors [loss] or may detect the erroneous course and pass information and instruction to the flight crew [corruption].
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.
- Compliance with the ICAO Safety Objectives (detailed in Table 5) demonstrates that the likelihood of a corruption of GNSS Data is low ***(SR01):*** *The integrity and accuracy of the navigation aids used for instrument approaches are such that they will provide the crew of participating aircraft*

with sufficiently reliable and accurate guidance to enable them to follow the published IAP within the tolerable limits required to avoid flight into terrain or obstacles.

Given the mitigating factors and the above derived Safety Requirement, it is argued that the likelihood of a corruption of all navigational data resulting in a CATASTROPHIC event is IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.4 Analysis of Hazard HAZ 03 (All options)

HAZ 03 Loss/Corruption of Voice Communication (Air-Ground): *LBHA ATC is unable to pass information to aircraft. Pilots are unable to communicate with ground stations.*

The possible causes of HAZ 03 are equipment and human based:

- Failure of equipment relating to the ATC task, e.g., LBHA radio failure.
- Failure of on-board aircraft equipment.
- Human error, e.g., manual or accidental disabling of radio.

The worst-case consequence of HAZ 03 could be CFIT or MAC.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as CATASTROPHIC.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of mitigations have been identified and are recorded as Safety Requirements that limit the likelihood of such consequences of a loss/corruption of Voice Communications (Air-Ground).

- If transponder equipped, aircraft will SQUAWK 7600 for loss of voice communications (if detected).
- In the event of a loss of Comms, the Aircraft should follow Loss of Comms procedure as laid out in the AIP entry for LBHA ***(SR02)***.
- The flight crew will acknowledge information passed from LBHA ATC, so a corruption/erroneous broadcast is likely to be detected.
- LBHA would expect a pilot who had suffered a loss of communications to continue their approach (in accordance with the last received 'ATC Clearance') as they would be unable to communicate any change of intentions and are not expecting any form of clearance to proceed.
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.

It is argued that the likelihood of a loss/corruption of Air-Ground Voice Communications resulting in a CATASTROPHIC event is considered IMPROBABLE, assuming that LBHA ATC Voice Communications is compliant with the applicable requirements of CAP 670, Air Traffic Services Safety Requirements [Ref. 13] ***(SR03)***.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.5 Analysis of Hazard HAZ 04 (All options)

HAZ 04 Loss/Corruption of Ground Comms to Other Aerodromes/ Agencies: *LBHA cannot pass or receive information with Redhill, RAF Kenley, Thames Radar, LGW, LCY, and Farnborough.*

This hazard relates to a loss/corruption of Ground Communications to Other Aerodromes/Agencies and results in controllers being unable to coordinate to ensure safe separation between mixed arrivals and departures.

The possible causes of HAZ 04 are equipment and human based:

- Communications equipment failure at LBHA or other Air Navigation Service Provider (ANSP)/Agencies.
- A loss of power to the Main BT Exchange at LBHA or other ANSP/ Agencies.
- Human error (co-ordination call not made).

The worst-case consequence of HAZ 04 could be a reduction in separation between aircraft. Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as MAJOR.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of mitigations have been identified and are recorded as Safety Requirements that limit the likelihood of such consequences of HAZ 04.

- In accordance with the Air Navigation Order (ANO), aircraft should continue to talk to the ATC unit that issued the last clearance.
- The flight crew will be in two-way voice communications with either Thames Radar (when in CAS) or LBHA ATC, and so can respond to ATC instructions accordingly.

LBHA currently has several layers of redundancy for telephone based communications:

- 2 x direct lines to Thames Radar ***(SR04)***.
- Speed dials via voice switch to local ANSPs/agencies ***(SR05)***.
- Additional speed dial to Redhill to be implemented ***(SR06)***.
- Mobile phone numbers recorded in MATS Part 2 ***(SR07).***

Therefore, the likelihood of a loss/ corruption of Ground Communications to Other Aerodromes/ Agencies resulting in a MAJOR event is assessed as being IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.6 Analysis of Hazard HAZ 05 (All options)

HAZ 05 Loss of Thames Radar surveillance*: Loss of feed to ATM and loss of surveillance services to IFR aircraft on approach to LBHA*

This hazard relates to a loss of surveillance from Thames Radar, meaning that aircraft will be operating in CAS without appropriate monitoring and the ATM at LBHA would be inoperable. This could be caused by a surveillance system failure or power failure.

The worst case consequence of HAZ 05 could be a reduction in separation between aircraft.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as a MAJOR event.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of inherent mitigations exist that limit the likelihood of such consequences of a loss of Thames Radar surveillance.

- Should HAZ 05 occur, the whole LTMA will close down, and flight crew would continue on previous clearance or go to a hold.
- If the loss of surveillance occurs once the aircraft is outside of CAS, then it will have no impact on the aircraft continuing the RWY21 RNAV(GNSS) IAP.
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.
- LBHA MATS Part 2 [Ref. 03] must cover the process to be followed if surveillance is lost ***(SR08)***.
- LBHA Approach Control will provide a Procedural Service for LBHA IFR traffic ***(SR09)***.

To allow the LTMA to function, Thames Radar will have several layers of redundancy available in terms of radar coverage and power supplies to individual radars. Therefore, the likelihood of a loss of Thames Radar surveillance resulting in a MAJOR event is assessed as being EXTREMELY IMPROBABLE.

Therefore, the level of risk is considered to be **ACCEPTABLE** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.7 Analysis of Hazard HAZ 06 (All options)

HAZ 06 Corruption of Thames Radar surveillance*: Corruption of feed to ATM and loss of surveillance services to IFR aircraft on approach to LBHA*

This hazard relates to a corruption of surveillance data from Thames Radar, meaning that aircraft will be operating in CAS with incorrect monitoring and the ATM at LBHA would be showing incorrect data. This is most likely to be caused by a surveillance system malfunction.

The worst case consequence of HAZ 06 could be a reduction in separation between aircraft.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as a MAJOR event.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of inherent mitigations exist that limit the likelihood of such consequences of corruption of Thames Radar surveillance.

- Should HAZ 06 occur, it will affect the whole LTMA. *If detected*, the LTMA will close down, and flight crew would continue on previous clearance or go to a hold.
- If HAZ 06 occurs once the aircraft is outside of CAS, then it will have no impact on the aircraft continuing the RWY21 RNAV(GNSS) IAP.

- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.
- ATC will intervene when large difference recognised.
- LBHA Approach Control will provide a Procedural Service for LBHA IFR traffic ***(SR09)***.

To allow the LTMA to function, Thames Radar will have a robust surveillance system with integrity monitoring. Therefore, it is argued that the likelihood of a corruption of Thames Radar surveillance resulting in a MAJOR event can be assessed as being IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.8 Analysis of Hazard HAZ 07 (All options – existing hazard)

HAZ 07 Multiple aircraft using the IAP at any one time*: Multiple aircraft using the IAP at any one time with different speeds.*

This hazard relates to a conflict between two aircraft using the same RWY21 RNAV(GNSS) IAP at LBHA. This is most likely to be caused by the procedure design constrained by the limited airspace around LBHA, noting the close proximity of LCY and LGW airspace. This means there is little opportunity to slow down or delay a faster aircraft.

The worst case consequence of HAZ 07 could be a reduction in separation between aircraft that requires ATC and Flight crew intervention.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as a MAJOR event.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of mitigations have been identified and are recorded as Safety Requirements that limit the likelihood of such consequences of HAZ 07.

- Thames Radar will ensure a minimum separation of 6NM (controlled tactically if necessary), as explained during the HazID workshop [Ref. 07].
- Spacing between LBHA IFP inbounds will be agreed with Thames Radar on a tactical basis at the time (LBHA MATS Part 2 [Ref. 03]).
- Thames Radar will provide radar services to IFR flights arriving or departing from Biggin Hill, regardless of the service requested by the pilot (MATS Part 2 [Ref. 03]).
- Thames Radar provides an Approach Surveillance Service to Biggin Hill IFR traffic requiring a surveillance service. Biggin Approach will co-ordinate all IFR traffic wishing to operate into controlled airspace with Thames Radar (MATS Part 2 [Ref. 03]).
- LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] ***(SR10)***.
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.
- LBHA RWY21 RNAV(GNSS) IAP shall be designed with holding patterns ***(SR11)***.

Given the above mitigations, it is argued that the likelihood of multiple aircraft using the IAP at any one time resulting in reduction in separation is a MAJOR event, assessed as being EXTREMELY IMPROBABLE.

Therefore, the level of risk is considered to be **ACCEPTABLE** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.9 Analysis of Hazard HAZ 08 (Option 2A and Option 2B)

HAZ 08 No radar vectors provided between OSVEV and ALKIN*: No connectivity between OSVEV and ALKIN.*

This hazard relates to the lack of connectivity between OSVEV and ALKIN in the RWY21 RNAV(GNSS) IAP at LBHA Option 2A and Option 2B. In the event of communication failure or NATS (Thames Radar) unavailability, no radar vectors would be provided leading to flight crew workload issues.

The worst case consequence of HAZ 08 could be a reduction in separation between aircraft requiring Flight crew intervention.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as a MAJOR event.

In respect of an aircraft flying the RWY21 RNAV(GNSS) IAP at LBHA, a number of mitigations have been identified and are recorded as Safety Requirements that limit the likelihood of such consequences of HAZ 08.

- In the event of a loss of Comms, the Aircraft should follow Loss of Comms procedure as laid out in the AIP entry for LBHA ***(SR02)***.
- LBHA opening hours match those of Thames Radar service, Thames Radar, therefore, NATS unavailable should be a very rare occurrence.
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.
- LBHA RWY21 RNAV(GNSS) IAP shall be designed with a link between OSVEV and ALKIN ***(SR12)***.

Further, it is considered that this hazard is an existing hazard and could be apparent with current operations at LBHA.

Given the mitigating factors and the above derived Safety Requirement, it is argued that the likelihood of no radar vectors provided between OSVEV and ALKIN resulting in a MAJOR event is EXTREMLEY IMPROBABLE.

Therefore, the level of risk is considered to be **ACCEPTABLE** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.10 Analysis of Hazard HAZ 13 (Option 9 – existing hazard)

HAZ 13 MAP conflict with gliders flying at Kenley airfield: *Conflict in Class G airspace due to aircraft conducting RWY21 RNAV(GNSS) MAP and winch-launched glider operations around RAF Kenley.*

The RWY21 RNAV(GNSS) MAP routes in close proximity to RAF Kenley. This could lead to a reduction in separation between aircraft and in the worst case, resulting in MAC.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as CATASTROPHIC.

The likelihood of this proximity of routings resulting in a CATASTROPHIC event is limited by the following mitigating factors:

- LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] ***(SR10)***.
- The presence of the RWY21 RNAV(GNSS) MAP is to be depicted in the UK IAIP and on aeronautical charts (final approach) (Chevron on VFR Charts) ***(SR14)***.
- There is no history of Airprox events between gliders from RAF Kenley and aircraft operating in/out of LBHA.
- In respect of an aircraft flying the RWY21 RNAV(GNSS) MAP, the aircraft commander remains responsible for separation (since it will be within Class G airspace); Rules of the Air – See and Avoid. "Powered" air traffic will be obliged to give way to gliders.

LBHA has offered to supply RAF Kenley users with ADS-B portable transponders. This will aid electronic conspicuity to IFR aircraft flying the RWY21 RNAV(GNSS) MAP. This represents a valuable mitigation but is not considered as a Safety Requirement, since the use of the RWY 21 MAP cannot be dependent upon this.

Given the above Safety Requirements and contextual statements, it is argued that the likelihood of HAZ 13 resulting in a CATASTROPHIC event is IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.11 Analysis of Hazard HAZ 14 (Option 9)

HAZ 14 Increased Flight Crew workload*: Flight Crew workload increase.*

This hazard relates to an increase of Flight Crew workload as multiple actions are required to perform the RWY21 RNAV(GNSS) MAP. This is most likely to be caused by the procedure design constrained by the limited airspace around LBHA, noting the close proximity of LCY and LGW airspace.

HAZ 14 could lead to a reduction in separation between aircraft that requires flight crew intervention.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as MAJOR.

In respect of an aircraft flying the RWY21 RNAV(GNSS) MAP at LBHA, a number of inherent mitigations exist that limit the likelihood of such a consequence of HAZ 14.

- The RWY21 RNAV(GNSS) MAP should be flown via the FMS – removing the risk of pilot handling error.
- In days with good visibility, fight crew may decide to flight manually to avoid conflict with aircraft transiting the local area.
- The RWY21 RNAV(GNSS) MAP is designed in accordance with PANS-OPS. Therefore, flight crew workload has been considered.
- LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] ***(SR10)***.

- Gatwick Airport ATC will detect potential infringing aircraft through the Controlled Airspace Infringement Tool (CAIT).
- The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.

Given the above mitigations, it is argued that the likelihood of increase flight crew workload resulting in reduction in separation is a MAJOR event, assessed as being IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.12 Analysis of Hazard HAZ (I)01 (Options 'I')

HAZ (I)01 Increased Flight Crew workload (switching from RNAV to ILS)

This hazard relates to an increase of Flight Crew workload caused by the need to switch from RNAV to ILS, during a period of already high cockpit workload.

HAZ (I)01 could lead to a reduction in separation between aircraft that requires flight crew intervention.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as MAJOR.

The likelihood of this hazard resulting in a MAJOR event is limited by the following mitigating factors:

- LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] ***(SR10)***.
- Thames Radar provides an Approach Surveillance Service to Biggin Hill IFR traffic requiring a surveillance service. Biggin Approach will co-ordinate all IFR traffic wishing to operate into controlled airspace with Thames Radar (MATS Part 2 [Ref. 03]).
- There shall be a speed limit for the RNAV to ILS procedure ***(SR16)***.

Given the above mitigations, it is argued that the likelihood of increase flight crew workload resulting in reduction in separation is a MAJOR event, assessed as being IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.13 Analysis of Hazard HAZ (I)02 (Options 'I')

This hazard relates to the switch to ILS from RNAV not being made. This is a causal factor of Hazard HAZ (I)03. See 4.2.14.

4.2.14 Analysis of Hazard HAZ (I)03 (Options 'I')

HAZ (I)03 Aircraft does not establish on ILS

This hazard relates to the event in which the aircraft does not establish on the ILS; this could be caused by Flight Crew error, aircraft system fault or the IAP design (e.g., excessive turn angles).

This may lead to the aircraft not commencing approach procedure and maintaining altitude, and thus could result in a potential loss of horizontal and/or vertical separation between aircraft.

Considering the above and using the Severity Classification Scheme in Annex A3.1, this hazard is classified as MAJOR.

The likelihood of this hazard resulting in a MAJOR event is limited by the following mitigating factors:

- LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] ***(SR10)***.
- Thames Radar provides an Approach Surveillance Service to Biggin Hill IFR traffic requiring a surveillance service. Biggin Approach will co-ordinate all IFR traffic wishing to operate into controlled airspace with Thames Radar (MATS Part 2 [Ref. 03]).
- There shall be a speed limit for the RNAV to ILS procedure ***(SR16)***.

Given the above mitigations, it is argued that the likelihood of HAZ (I)03 resulting in reduction in separation is a MAJOR event, assessed as being IMPROBABLE.

Therefore, the level of risk is considered to be **REVIEW** in accordance with the Risk Tolerability Matrix presented in Annex A3.3.

4.2.15 Analysis of Hazard HAZ (I)04 (Option 9)

This hazard relates to the flight crew needing to switch to RNAV from ILS during a MAP, adding to an already high cockpit workload situation. This is a causal factor of Hazard HAZ 14. See 4.2.11.

4.2.16 Analysis of Hazard HAZ (I)05 (Option 9)

This hazard relates to a loss of the GNSS SiS. This hazard has already been captured as Hazard HAZ 01 – see 4.2.2.

4.2.17 Safety Requirements Summary

A consolidated list of Safety Requirements is presented in xx below.

Ref.	Safety Requirement	Linked Hazard	Source
SR01	The integrity and accuracy of the navigation aids used for instrument approaches are such that they will provide the crew of participating aircraft with sufficiently reliable and accurate guidance to enable them to follow the published IAP within the tolerable limits required to avoid flight into terrain or obstacles.	HAZ 01 HAZ 02	4.2.2 4.2.3
SR02	In the event of a loss of Comms, the Aircraft should follow Loss of Comms procedure as laid out in the AIP entry for LBHA	HAZ 03 HAZ 08	4.2.4 4.2.9

Ref.	Safety Requirement	Linked Hazard	Source
SR03	LBHA ATC Voice Communications is compliant with the applicable requirements of CAP670, Air Traffic Services Safety Requirements [Ref. 13]	HAZ 03	4.2.4
SR04	LBHA shall have 2 x direct lines to Thames Radar	HAZ 04	4.2.5
SR05	LBHA shall have Speed dials via voice switch to local ANSPs/agencies	HAZ 04	4.2.5
SR06	LBHA shall have an additional speed dial to Redhill	HAZ 04	4.2.5
SR07	LBHA shall have mobile phone numbers recorded in MATS Part 2 [Ref 03].	HAZ 04	4.2.5
SR08	LBHA MATS Part 2 [Ref 03] must cover the process to be followed if surveillance is lost	HAZ 05	4.2.6
SR09	LBHA Approach Control will provide a Procedural Service for LBHA IFR traffic	HAZ 05 HAZ 06	4.2.6 4.2.7
SR10	LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10]	HAZ 01 HAZ 07 HAZ13 HAZ14	4.2.2 4.2.8 4.2.10 4.2.11
SR11	LBHA RWY21 RNAV(GNSS) IAP shall be designed with holding patterns.	HAZ 07	4.2.8
SR12	LBHA RWY21 RNAV(GNSS) IAP shall be designed with a link between OSVEV and ALKIN	HAZ08	4.2.9
SR13	*Not used*		
SR14	The presence of the RWY21 RNAV(GNSS) MAP is to be depicted in the UK IAIP and on aeronautical charts (final approach) (Chevron on VFR Charts).	HAZ13	4.2.10
SR15	*Not used*		
SR16	There shall be a speed limit for the RNAV to ILS procedure	HAZ (I)01	4.2.12 4.2.14

Ref.	Safety Requirement	Linked Hazard	Source
		HAZ (I)03	

Table 6: RWY21 RNAV(GNSS) IAP Safety Requirements

4.3 Statutory and Regulatory Requirements

4.3.1 Airspace and Infrastructure Requirements

A key element of the ACP is the need to demonstrate that the proposed changes comply with the Airspace and Infrastructure requirements as set out in Appendix F of CAP 1616 [Ref. 04].

These requirements are derived from the Single European Sky (SES) Regulations, ICAO Standards and Recommended Practises (SARPs) and European Civil Aviation Conference (ECAC)/EUROCONTROL requirements; the list also includes additional requirements to satisfy UK policy.

4.3.2 Procedure Design Requirements

CAP 785 [Ref. 15] provides guidance on the approval of Instrument Flight Procedure (IFP) produced by the approved procedure designers.

The criterion for IFP design in UK Airspace is based on ICAO Document PANS-OPS 8168 [Ref. 16] and CAP 785 provides detail on the format and content of an IFP Design Submission (see sub-Sections 2 to 4 of Section 3, Chapter 1 of CAP 785).

Additionally, CAP 670, Air Traffic Services Safety Requirements [Ref. 15], section NAV07 details ATS Requirements for RNAV(GNSS) Instrument Approach Procedures.

5 References

Ref	Title	Origin
[Ref. 01]	London Biggin Hill Airport, Management Manual Revision 9, 01 November 2020	LBHA
[Ref. 02]	CAP 168, Licensing of Aerodromes Edition 11, January 2019	CAA
[Ref. 03]	London Biggin Hill Airport Manual of Air Traffic Services Part 2 Edition 2.3 / January 2021	LBHA
[Ref. 04]	CAP 1616 Airspace Design: Guidance on the regulatory process for changing airspace design including community engagement requirements. V4 Issued March 2021	CAA
[Ref. 05]	71372 010 Stage 2 Design Options - Public Focus Group Minutes	Osprey
[Ref. 06]	London Biggin Hill Airport, Aerodrome Manual Revision 8, 01 January 2021	LBHA
[Ref. 07]	LBHA RWY21 RANV(GNSS) IAP HazID Record 71372 013, Issue 2, 16 April 2021	Osprey
[Ref. 08]	LBHA RWY21 RANV(GNSS) IAP HazID Briefing Pack 71372 006, Issue 1, 7 May 2021	Osprey
[Ref. 09]	London Biggin Hill Airport RNAV (GNSS) Runway 21 Airspace Change Proposal ACP-2019-86 Stage 2 Version 2 Design Options Development Document Version 2 Design Options Development Document Issue 1 - FINAL 10th March 2022	Osprey
[Ref. 10]	CAP 493, Manual of Air Traffic Services – Part 1 June 2020	CAA

Ref	Title	Origin
[Ref. 11]	London Biggin Hill Airport, RNAV (GNSS) Runway 21, Airspace Change Proposal, ACP-2019-86 Stage 2 Version 2 Design Principles Evaluation Gateway 2 FINAL Stage 2 Version 2 Design Principles Evaluation Gateway 2 3rd March 2022	Osprey
[Ref. 12]	ICAO Annex 10 Volume I (Radio Navigation Aids) Fifth Edition Of Volume I — July 1996	ICAO
[Ref. 13]	CAP 670 Air Traffic Services Safety Requirements Third Issue, Amendment 1/2019, 1 June 2019, Effective 1 August 2019	CAA
[Ref. 14]	Policy for the Establishment of Visual Reference Points Version 2, July 2019	CAA
[Ref. 15]	CAP 785 Approval Requirements for Instrument Flight Procedures for Use in UK Airspace 22 March 2010.	CAA
[Ref. 16]	ICAO Doc 8168 - Procedures for Air Navigation Services Aircraft Operations – Volume II Construction of Visual and Instrument Flight Procedures	ICAO
[Ref. 17]	Meeting Notes LBHA Airspace Change – RWY21 IAP: RNAV to ILS element HazID 71372/021, Issue 2	Osprey

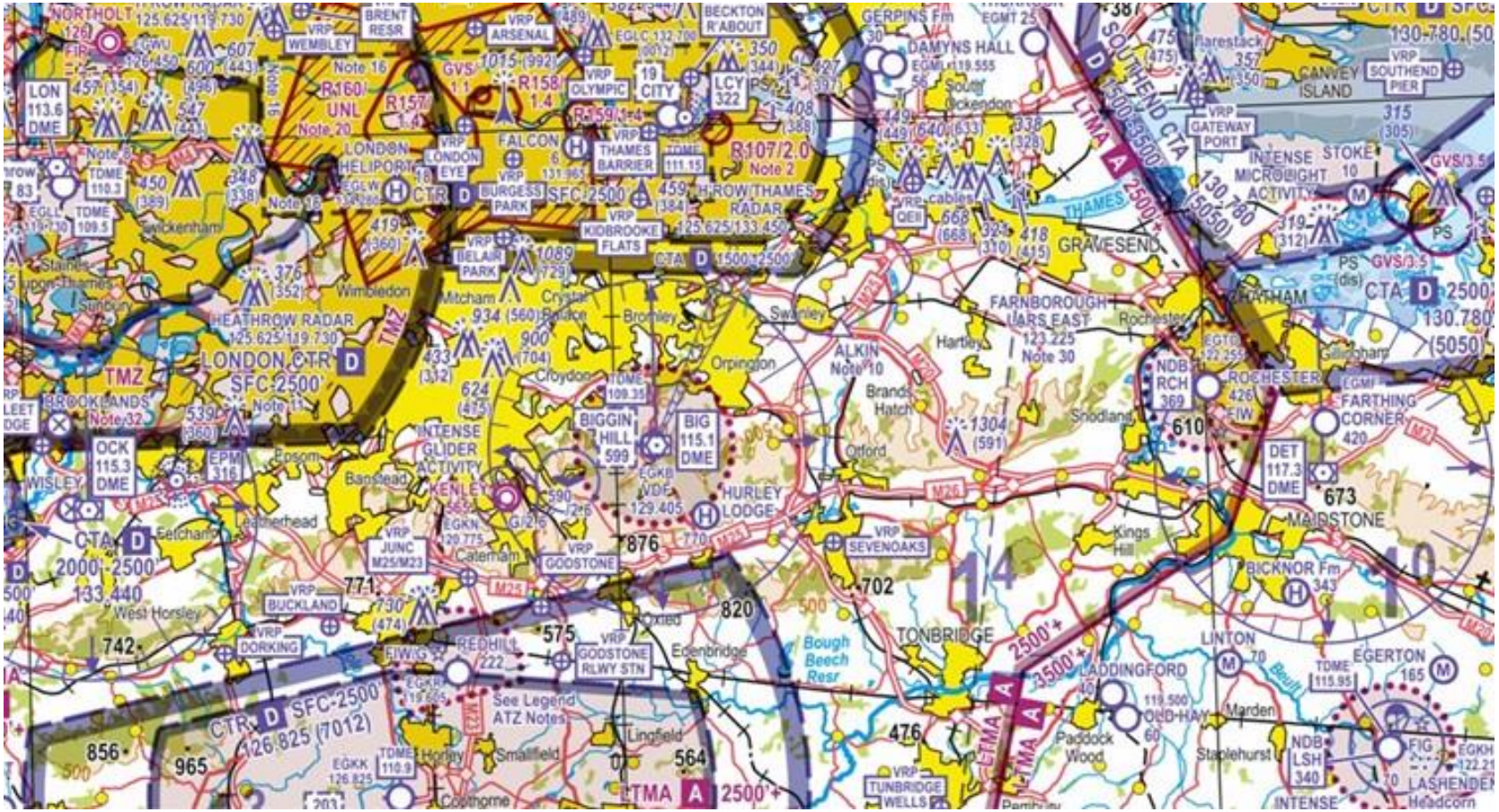
6 Glossary

Term	Meaning
ACP	Airspace Change Proposal
AGL	Aeronautical Ground Lighting
AIP	Aeronautical Information Publication
amsl	above mean sea level
ANO	Air Navigation Order
ANSP	Air Navigation Service Provider
APV	Approach with Vertical Guidance
ASDA	Accelerate Stop Distance Available
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATM	Aerodrome Traffic Monitor
ATS	Air Traffic Service
ATZ	Aerodrome Traffic Zone
CAA	Civil Aviation Authority
CAS	Controlled Airspace
CFIT	Controlled Flight into Terrain
CTA	Control Area
CTR	Control Zone
CWP	Controller Working Positions
D&D	Distress and Diversion
DME	Distance Measuring Equipment
DRDF	Doppler Radio Direction Finder
FMS	Flight Management System

Term	Meaning
GNSS	Global Navigation Satellite System
HazID	Hazard Identification
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
IFR	Instrument Flight Rules
ILS	Instrument Landing System
LBHA	London Biggin Hill Airport
LCY	London City Airport
LDA	Landing Distance Available
LFA	Local Flying Area
LGW	London Gatwick Airport
LNAV	Lateral Navigation
LPV	Vertical Guidance
LTCC	London Terminal Control Centre
LTMA	London Terminal Control Area
MAC	Mid Air Collision
MAP	Missed Approach Procedure
MATS	Manual Air Traffic Services
MOR	Mandatory Occurrence Report
NM	Nautical Mile
PAPI	Precision Approach Path Indicator
PH	Public Holiday
PPR	Prior Permission Required
RAF	Royal Air Force

Term	Meaning
RAIM	Receiver Autonomous Integrity Monitoring
RNAV	Area Navigation
RWY	Runway
SARG	Airspace Regulation Group
TC	Terminal Control
TODA	Take-off Distance Available
TORA	Take-off Run Available
UK	United Kingdom
UTC	Coordinated Universal Time
VCCS	Voice Communications and Control System
VDF	VHF Direction Finder
VFR	Visual Flight Rules
VGS	Volunteer Gliding Squadron
VOR	VHF Omnidirectional Range
VRP	Visual Reference Points

A1 Current Airspace in the Vicinity of LBHA



A2 LBHA RWY21 RNAV(GNSS) IAP Options

RWY21 RNAV (GNSS) IAP Options are presented within the Stage 2 Design Options Development Document [Ref. 09).

A3 Risk Tolerability Criteria

Taken from the LBHA MM [Ref. 01].

A3.1 Severity Classification Scheme

BHAL SEVERITY OF CONSEQUENCES		
Aviation definition	**Meaning**	**Value**
Catastrophic	Results in an accident, death or equipment destroyed	A
Hazardous	Serious injury or major equipment damage	B
Major	Serious incident or injury	C
Minor	Results in a minor incident	D
Negligible	Nuisance of little consequence	E

BHAL Severity	Negligible (E)	Minor (D)	Major (C)	Hazardous (B)	Catastrophic (A)
Safety Damage	Property / Equipment damage up to £1,000	Property / Equipment damage between £1,000 and £10,000	Property / Equipment damage between £10,000 and £100,000	Property / Equipment damage between £100,000 and £250,000	Property / Equipment damage over £250,000
Safety Environment	Limited damage to minimal area of low significance	Minor effects on biological or physical environment	Moderate short-term effects but not affecting eco-system	Serious medium term environmental effects	Very serious long term environmental impairment of eco-system
ESARR4 Severity	No Safety Effect (Severity Class 5)	Significant Incidents (Severity Class 4)	Major Incidents (Severity Class 3)	Serious Incidents (Severity Class 2)	Accidents (Severity Class 1)
CAP 760 Severity	No Effect Immediately	Significant Incidents	Major Incidents	Serious Incidents	Accidents
NATS Safety Outcome Severity Class	No Safety Effect (Severity Class 4)	Significant Incident (Severity Class 3)	Major Incident (Severity Class 2)	Serious Incident (Severity Class 1)	Accident (Through Serious Incident)
NATS Flight Interpreted Outcome	Negligible	Minor	Major	Hazardous	Catastrophic

A3.2 Probability/Likelihood Classification

BHAL LIKELIHOOD OF OCCURRENCE		
Qualitative definition	**Meaning**	**Value**
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

BHAL Likelihood		Extremely Improbable (1)	Improbable (2)	Remote (3)	Occasional (4)	Frequent (5)
NATS	Quantitative per operational hour per sector)	10^{-9} or less (Extremely Improbable)	10^{-7} up to 10^{-9} (Extremely Improbable)	10^{-5} up to 10^{-7} (Remote & Improbable)	10^{-3} up to 10^{-5} (Probable & Occasional)	Up to 10^{-3} (Frequent)
CAP 760	Qualitative definition	Should virtually never occur	Very unlikely to occur	Unlikely to occur during the total operational life of the system	May occur once during total operational life of the system	May occur several times during operational life
CAP 760	Quantitative numerical definition	< 10^{-9} per hour	10^{-7} to 10^{-9} per hour	10^{-5} to 10^{-7} per hour	10^{-3} to 10^{-5} per hour	1 to 10^{-3} per hour
CAP 760	Quantitative annual/daily equivalent (approximate)	Never	Once in 1,000 years to 100,000 years	Once in 10 years to once in 1,000 years	Once per 40 days to once in 10 years	Once per hour to once in 40 days

A3.3 Risk Classification/Tolerability Matrix

Risk Likelihood	Risk Severity				
	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5 (up to 10^{-3})	Unacceptable 2500	Unacceptable 1000	Undesirable 300	Review 100	Review 1 (G)
Occasional 4 (10^{-3} up to 10^{-5})	Unacceptable 1000	Undesirable 300	Review 100	Review 40	Review 1 (G)
Remote 3 (10^{-5} up to 10^{-7})	Undesirable 300	Review 100	Review 40	Review 10 (G)	Acceptable 1
Improbable 2 (10^{-7} up to 10^{-9})	Review 100	Review 40	Review 10 (G)	Acceptable 4	Acceptable 1
Extremely Improbable 1 (10^{-9} or less)	Review 50	Acceptable 20 (Y)	Acceptable 5	Acceptable 2	Acceptable 1

A3.4 Risk Toleration Description

- **UNACCEPTABLE**: The risk is unacceptable and shall be terminated, treated (mitigated to an acceptable level) or transferred (to another organisation).
- **UNDESIRABLE**: The risk is undesirable and major mitigation measures are required to reduce the level of risk to as low as reasonably practicable. Undesirable risks may be approved by the Accountable Manager for one-off activities, but this is not envisaged for long term activities.
- **REVIEW**: The level of risk is of concern and mitigation measures are required to reduce the level of risk to as low as reasonably practicable. Where further risk reduction/mitigation is not practical or viable, the risk may be accepted, provided that the risk is understood and has the endorsement of the Accountable Manager or Head of Department (SATCO, SAFO, Operations Director, Head of Airport Operations, Head of Fixed Base Operations, CFO, BDD).
- **ACCEPTABLE**: Risk is considered acceptable but should be reviewed if it reoccurs or changes that affect the risk are made. Acceptable risks may be signed off by the Safety Manager, Head of Department (listed in Review), the Operations Director or the Accountable Manager.

A4 Risk Assessment Summary

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ 01	Loss of Navigational Information	All	GNSS outage FMS failure Human error (flight crew)	Potential for Loss of horizontal and/or vertical separation between aircraft. In the case of a RWY21 MAP, Aircraft infringes the London Gatwick Airport CTA. Flight Crew situational awareness is diminished. Worst Case: CFIT or MAC.	Catastrophic	Remote	Undesirable	Compliance with the ICAO Safety Objectives demonstrates that the likelihood of a loss of GNSS Data is low **(SR01)**. The loss of navigational data is likely to be detected (navigational systems will fail to function, RAIM Alert). The flight crew will be in two-way voice communications with either Thames Radar (when in CAS) or LBHA ATC, and so can respond to ATC instructions accordingly. If still within CAS, Thames Radar can provide radar vectors. LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] **(SR10)**. Gatwick Airport ATC will detect potential infringing aircraft through the Controlled Airspace Infringement Tool (CAIT). There are alternative IAPs at LBHA that use terrestrial navigational aids (ILS approach). If appropriate (with consideration to meteorological conditions) the flight crew can perform a conventional IAP to RWY 21. If necessary, a diversion to another aerodrome. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.	Catastrophic	Extremely Improbable	Review

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ 02	Corruption of Navigational Information	All	GNSS outage FMS failure Human error (flight crew)	Potential for Loss of horizontal and/or vertical separation between aircraft. Flight Crew situational awareness is diminished. Worst Case: CFIT or MAC.	Catastrophic	Remote	Undesirable	Compliance with the ICAO Safety Objectives demonstrates that the likelihood of a loss of GNSS Data is low **(SR01)**. The corruption of navigational data may be detected via, RAIM Alert. If still within CAS, Thames Radar can provide radar vectors. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid	Catastrophic	Improbable	Review
HAZ 03	Loss/Corruption of Voice Communication (Air-Ground)	All	ATC Comms system failure. Electrical system failure Power system failure Aircraft Comms system failure Human Error (e.g. manual or accidental disabling of radio)	Potential for Loss of horizontal and/or vertical separation between aircraft. Flight Crew situational awareness is diminished. Worst Case: CFIT or MAC.	Catastrophic	Remote	Undesirable	If transponder equipped, aircraft will SQUAWK 7600 for loss of voice communications (if detected). In the event of a loss of Comms, the Aircraft should follow Loss of Comms procedure as laid out in the AIP entry for LBHA **(SR02)**. The flight crew will acknowledge information passed from LBHA ATC, so a corruption/erroneous broadcast is likely to be detected. LBHA would expect a pilot who had suffered a loss of communications to continue their approach (in accordance with the last received 'ATC Clearance') as they would be unable to communicate any change of intentions and are not expecting any form of clearance to proceed. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid. LBHA ATC Voice Communications is compliant with the applicable requirements of CAP670, Air Traffic Services Safety Requirements [Ref. 13] **(SR03)**.	Catastrophic	Improbable	Review

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ 04	Loss/Corruption of Ground Comms to Other Aerodromes/ Agencies	All	Comms equipment failure at LBHA or other Air Navigation Service Provider (ANSP)/agency Loss of power to the Main BT Exchange at LBHA or other ANSP/agency. Human error (co-ordination call not made).	Potential for Loss of horizontal and/or vertical separation between aircraft. *Air Traffic Controllers unable to coordinate to ensure safe separation between mixed arrivals and departures.*	Major	Remote	Review	In accordance with the ANO, aircraft should continue to talk to the ATC unit that issued the last clearance. The flight crew will be in two-way voice communications with either Thames Radar (when in CAS) or LBHA ATC, and so can respond to ATC instructions accordingly. LBHA currently has several layers of redundancy for telephone-based communications: • 2 x direct lines to Thames Radar **(SR04)**. • Speed dials via voice switch to local ANSPs/agencies **(SR05)**. • Additional speed dial to Redhill to be implemented **(SR06)**. • Mobile phone numbers recorded in MATS Part 2 **(SR07)**.	Major	Improbable	Review
HAZ 05	Loss of Thames Radar surveillance	All	Surveillance System failure Power supply failure	Potential for Loss of horizontal and/or vertical separation between aircraft. *LTMA will close down and flight crew would continue on previous clearance or go to a hold.* *Aircraft will be operating in CAS without appropriate monitoring.*	Major	Improbable	Review	If the loss of surveillance occurs once the aircraft is outside of CAS, then it will have no impact on the aircraft continuing the RWY21 RNAV(GNSS) IAP. LBHA MATS Part 2 [Ref 03] must cover the process to be followed if surveillance is lost **(SR08)**. LBHA Approach Control will provide a Procedural Service for LBHA IFR traffic **(SR09)**. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.	Major	Extremely Improbable	Acceptable

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ 06	Corruption of Thames Radar surveillance	All	Surveillance System malfunction.	Potential for Loss of horizontal and/or vertical separation between aircraft. *If detected, LTMA will close down and flight crew would continue on previous clearance or go to a hold.* *Aircraft will be operating in CAS without appropriate monitoring.*	Major	Remote	Review	ATC intervention when large differences recognised. If the corruption of surveillance occurs once the aircraft is outside of CAS, then it will have no impact on the aircraft continuing the RWY21 RNAV(GNSS) IAP. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid. LBHA Approach Control will provide a Procedural Service for LBHA IFR traffic **(SR09)**.	Major	Improbable	Review
HAZ 07	Multiple aircraft using the IAP at any one time	All	IAP Design constrained by limited airspace.	Potential for Loss of horizontal and/or vertical separation between aircraft.	Major	Improbable	Review	LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] (**SR10)**. Spacing between IFP inbounds will be agreed with Thames Radar on a tactical basis at the time as sated in the LBHA MATS Part 2 [Ref. 03]. Thames Radar will provide radar services to IFR flights arriving or departing from Biggin Hill, regardless of the service requested by the pilot (MATS Part 2 [Ref. 03]). Thames Radar provides an Approach Surveillance Service to Biggin Hill IFR traffic requiring a surveillance service. Biggin Approach will co-ordinate all IFR traffic wishing to operate into controlled airspace with Thames Radar (MATS Part 2 [Ref. 03]). The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid. LBHA RWY21 RNAV(GNSS) IAP shall be designed with holding patterns **(SR11).**	Major	Extremely Improbable	Acceptable

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ 08	No radar vectors provided between OSVEV and ALKIN	Option 2A Option 2B	ATC Comms system failure. Thames Radar /NATS unavailable. No connectivity between OKVEV and ALKIN.	Flight Crew workload increase. Potential for Loss of horizontal and/or vertical separation between aircraft.	Major	Remote	Review	In the event of a loss of Comms, the Aircraft should follow Loss of Comms procedure as laid out in the AIP entry for LBHA **(SR02)**. LBHA RWY21 RNAV(GNSS) IAP shall be designed with a link between OSVEV and ALKIN **(SR12)**. LBHA opening hours match those of Thames Radar service, Thames Radar/ NATS unavailable should be a very rare occurrence. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.	Major	Extremely Improbable	Acceptable
HAZ 13	MAP conflicts with gliders flying at Kenley airfield.	Option 9	Conflict between aircraft conducting RWY2 RNAV(GNSS) IAP and winch-launched glider operations around Kenley	Potential for Loss of horizontal and/or vertical separation between aircraft. Worst Case Scenario: MAC.	Catastrophic	Remote	Undesirable	LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] (**SR10)**. The presence of the RWY21 RNAV(GNSS) MAP is to be depicted in the UK IAIP and on aeronautical charts (final approach) (Chevron on VFR Charts) **(SR14)**. There is no history of Airprox events between gliders from RAF Kenley and aircraft operating in/out of LBHA. The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.	Catastrophic	Improbable	Review

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ 14	Increased Flight Crew workload (MAP)	Option 9	IAP Design Switch from ILS to RNAV	Flight Crew workload increase. Potential for Loss of horizontal and/or vertical separation between aircraft. Increase likelihood of an airprox. Incursion to Gatwick CTA/London Terminal Control Area (LTMA)	Major	Remote	Review	The RWY21 RNAV(GNSS) MAP should be flown via the FMS – removing the risk of pilot handling error. In days with good visibility, fight crew may decide to flight manually to avoid conflict with aircraft transiting the local area. The RWY21 RNAV(GNSS) MAP is designed in accordance with PANS-OPS. Therefore, flight crew workload has been considered. LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] **(SR10)**. Gatwick Airport ATC will detect potential infringing aircraft through the Controlled Airspace Infringement Tool (CAIT). The aircraft commander remains responsible for separation (Class G airspace); Rules of the Air – See and Avoid.	Major	Improbable	Review
HAZ I-01	Switch to ILS from RNAV adds to an already high cockpit workload situation	Option 2A/B/C I	IAP Design	Flight Crew workload increase. Potential for Loss of horizontal and/or vertical separation between aircraft. Incursion to LCY CTA/London Terminal Control Area (LTMA)	Major	Remote	Review	Speed limit for the procedure – gives flight crew more time **(SR16)**. LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] **(SR10)**. Thames Radar provides an Approach Surveillance Service to Biggin Hill IFR traffic requiring a surveillance service. Biggin Approach will co-ordinate all IFR traffic wishing to operate into controlled airspace with Thames Radar (MATS Part 2 [Ref. 03]).	Major	Improbable	Review
HAZ I-02	Switch from RNAV to ILS is not made	Option 2A/B/C I	Aircraft system fault Flight Crew error	*Cause of HAZ I-03* *See HAZ I-03*							

Node	Hazard	Option	Causes	Consequence (un-mitigated)	Pre-mitigation Severity	Pre-mitigation Likelihood	Pre-mitigation Risk	Mitigation	Post-mitigation Severity	Post-mitigation Likelihood	Post-mitigation Risk
HAZ I-03	Aircraft does not establish on ILS	Option 2A/B/C I	Aircraft system fault Flight Crew error IAP design (e.g., excessive turn angles)	Aircraft does not commence approach procedure and maintains altitude Potential for Loss of horizontal and/or vertical separation between aircraft. Incursion to LCY CTA/London Terminal Control Area (LTMA)	Major	Remote	Review	LBHA will be able to use advances ATM in accordance with Section 2, Chapter 1, para 21 of the MATS Part 1 [Ref. 10] **(SR10)**. Thames Radar provides an Approach Surveillance Service to Biggin Hill IFR traffic requiring a surveillance service. Biggin Approach will co-ordinate all IFR traffic wishing to operate into controlled airspace with Thames Radar (MATS Part 2 [Ref. 03]).	Major	Improbable	Review
HAZ I-04	Switch to RNAV from ILS adds to an already high cockpit workload situation	Option 9	High cockpit workload IAP Design constrained by limited airspace.	*Cause of HAZ 14* *See HAZ 14.*							
HAZ I-05	Loss of GNSS	All	*Already captured as HAZ 01*								