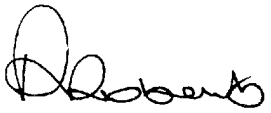


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DOCUMENT APPROVAL

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DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

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2	16 September 2015	Updated following review by TAPT, TASC and select individuals within CAA SARG	All
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Foreword

The introduction of a significantly raised Transition Altitude in the UK's Flight Information Regions is a large-scale project which will directly affect all UK airspace users and air traffic service providers. Consequently, the State Transition Altitude Safety Committee, which operates within the governance framework of the UK Transition Altitude Project, was established to ensure that an appropriate approach to safety is taken within the project, and that the proposed concept of operations has robust supporting safety assurance. This Final Safety Report, produced by the TA Safety Committee, has been developed in collaboration with all project partners and reflects the findings from project meetings and activities up-to-date.

The report is a marker in time and provides a valuable opportunity for the project partners to review the safety assurance developed so far and to identify actions required to support further evolution. It will be updated to reflect post-consultation activity and, in due course, its structure will be advocated as a basis for localised implementation safety analysis.



Colin Gill
Chair State Transition Altitude Safety Committee

Executive Summary

The purpose of this State Safety Assurance Report is to provide a documented argument that the State level changes associated with the raised Transition Altitude, as described within the Joint Concept of Operations for Inside and Outside of Controlled Airspace, is acceptably safe¹, or to highlight where this aim is yet to be met. The safety assurance argument is presented within this report utilising Goal Structuring Notation, which provides a graphical depiction of the 'flow' of the disparate elements of that argument.

The report makes the following key findings:

- Significant progress has been made towards developing the State CONOP document for the 2nd State consultation on implementing a harmonised, raised TA of 18 000ft for the UK, following the formal decision to go-ahead being taken in December 2013.
- Safety is being appropriately addressed within the project with suitably qualified and experienced personnel. Appropriate and proportionate safety processes are in place and the deliverables from these are 'alive' within the project and used to inform and direct project activity in order to mitigate identified safety risks.
- Validation of the TA of 18 000ft will be inferred through the successful validation of the associated ASR design and Airspace, ATC and flight crew procedures and from the outcome of the 2nd State Consultation in February 2016.
- It is reasonable to argue that a sufficient level of maturity exists within the ASR design.
- Safety analyses conducted by the Project partners have identified areas where further work is required to mitigate indicative risks on RTF load and ATCO workload, particularly at ASR boundaries. Consequently, at this stage of the project, it is not possible to state categorically that the proposed State airspace, flight crew and ATC procedures are acceptably safe.
- The residual safety effects of increased RTF loading and controller workload within CAS remain foremost within project stakeholder priorities. Analysis has indicated that, for MOD operations, the risks can be managed; however there is potential for a 2nd order safety effect through increases in service refusal to aircraft in Class G airspace and reduced accommodation of coordination requests, particularly as a transitional effect.

Whilst safety benefits from a raised TA were identified by attendees at a Class G airspace workshop, it is reasonable to argue that they were limited in their scope. Moreover, work conducted by NATS has indicated that, in relation to their operations inside CAS, a raised TA of 18 000ft alone does not provide direct safety benefits. However, a raised TA of 18 000ft is a vital enabler for future safety, environmental and economic benefits that will be realised through improvements to the vertical profiles of aircraft arrivals and departures in the London and Scottish FIRs. Consequently, at the time of writing, it is not possible to argue with confidence that the proposed change of a raised TA alone is at least safety neutral. However, at this stage of the project, the risks are considered to be indicative and clarity in the further mitigations and confidence in their delivery will be needed in order to inform a subsequent assessment of the safety effect of the change in TA.

Given the residual safety effects discussed above, the State will need to carefully consider the timing of TA implementation in the context of the roll out of future airspace projects for which the TA Project is seen as a key enabler. Specifically, how long can any potential increases in safety risk be accepted, before the benefits achieved through future airspace projects can be realised?

¹ 'Acceptably safe' is considered to mean that risks are acceptable, or tolerable and mitigated to ALARP.

1 Introduction

Background

- 1.1 A harmonised Transition Altitude (TA) of 18 000ft will be a key enabler of the UK's Future Airspace Strategy (FAS), with the intention of safely enhancing efficiency, both inside and outside controlled airspace, through the standardisation of airspace and altimeter setting procedures². This will provide the foundation for future safety, environmental and economic benefits that will be realised through improvements to the vertical profiles of aircraft arrivals and departures in the London and Scottish FIRs. It also serves as a platform for future airspace and operating concepts through programmes such as Single European Sky (SES), SES Air Traffic Management Research (SESAR), FAS, UK/Ireland Functional Airspace Block (FAB), the London Airspace Management Programme (LAMP) and the Northern Terminal Control Area (NTCA) Development Plan.
- 1.2 Raising the TA presents significant challenges, requiring a change of mind-set for pilots and ATS personnel alike, as well as a plethora of software upgrades, chart amendments and training at all levels to be developed. The vast amount of change process necessary imposes human factors and safety issues that must be appropriately addressed.

Purpose

- 1.3 The purpose of this State Safety Assurance Report (SSAR) is to provide a documented argument that the State level changes associated with the raised TA, as described within the Joint Concept of Operations (CONOP) for Inside and Outside of Controlled Airspace (CAS), is acceptably safe³, or to highlight where this aim is not yet met.

Scope

- 1.4 This SSAR summarises the safety assurance activities undertaken to date to derive high level safety requirements for the raised TA, to ensure that it contributes to the achievement of an *acceptable level of safety* and will continue to do so. Whilst the UK and Ireland are seeking the simultaneous implementation of a raised TA throughout the FAB, this SSAR only relates to the safety assurance of the UK TA project. It does not address the requirements of the FAB as a whole, nor other partner nations involved through the auspices of the UK/Ireland/Norway TA Oversight Group (UINTAOG).
- 1.5 Given the far reaching implications for airspace users of the proposed TA change, the project was established on a joint basis, with the UK CAA, NATS and the UK Ministry of Defence (MOD) acting as equal partners on what is termed a MOCOR3 basis; MOCOR being the Maturity of Cross Organisational Relationships. Annexe A contains more details on the MOCOR framework and explains the 3 broad levels of maturity.

Safety Regulatory Context

- 1.6 EU Regulation 1035/2011 requires that risk assessment and mitigation are conducted to an appropriate level to ensure that due consideration is given to all aspects of the provision of ATM⁴ and that complete arguments are established to demonstrate that the issue under consideration, as well as the overall ATM functional system, will remain tolerably safe by meeting allocated safety objectives and requirements⁵. Whilst EU 1035/2011 is a requirement on ANSPs rather than States or Competent Authorities, it provides suitable

² State TA CONOP Version 5.2 paragraph 1.1.

³ 'Acceptably safe' is considered to mean that risks are acceptable, or tolerable and mitigated to ALARP.

⁴ [EU Regulation 1035/2011 3.1.2 f](#)

⁵ [EU Regulation 1035/2011 3.2.3 a](#)

guidance for the safe management of the changes associated with raising the TA. Moreover, the UK's FAS details the State's commitment to the safe modernisation of the UK's ATM system⁶; specifically that:

- a. All changes are justified on the grounds that they will directly reduce the risk, and/or contribute, to the development of a fundamentally safer system or at the very least maintain current levels of safety whilst delivering benefits in other areas.
- b. The right levels of resource are in place to ensure that the transition to a future system can be executed safely.
- c. The appropriate regulatory mechanisms are in place to enable implementation of changes and assure the safety of the new system.

General Approach

- 1.7 The approach adopted in creating this SSAR was based on the guidelines contained within CAP 760 and Eurocontrol's Safety Assessment Made Easier Part 1.

Structure

- 1.8 The TA SSAR is sub-divided into a number of sections as follows:

- **Section 1** Introduction – presents an overview of the SSAR, its background, purpose and scope.
- **Section 2** References and Abbreviations
- **Section 3** System Description – Describes the scope of the UK ATM system changes proposed as a result of the harmonised TA, the nature of the risk identification and mitigation activity undertaken and details the safety requirements that have been identified.
- **Section 4** Overall Safety Argument – provides the top-level argument that the impact of the changes in the UK TA are acceptably safe in airspace within which the UK is responsible for ATS provision.
- **Section 5** The Revised UK TA Design is Acceptably Safe – will present the progress made in satisfying the goal that the revised UK TA design is acceptably safe.
- **Section 6** Civil Transition and Implementation, Military Transition and Implementation and Steady State Operation – will present the progress made in satisfying the goal that the transition, implementation and steady state operation of the change are acceptably safe.
- **Section 7** Assumptions, Issues and Limitations.
- **Section 8** Safety Risks and Benefits – Provides an overview of the safety risks that have been identified to date, alongside the safety benefits that have been identified as resulting from the implementation of a raised TA, that may be used to 'off-set' residual risk.

⁶ CAA Future Airspace Strategy for the UK 2011 to 2030.

- **Section 9** Conclusion.

1.9 The TA SSAR also contains the following Annexes:

- Annexe A – The Maturity of Cross Organisational Relationships (MOCOR) Framework.
- Annexe B – Proposed UK Altimeter Setting Region Map.
- Annexe C – Goal Structuring Notation (GSN).
- Annexe D – Meteorological Data.
- Annexe E – Safety Risk Correlation to CONOP and SSAR.

2 References & Abbreviations

References

2.1 The following references were used to support the creation of this SSAR.

- [1] CAP 760 Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases: For Aerodrome Operators and Air Traffic Service Providers, 10 December 2010.
- [2] Future Airspace Strategy for the UK 2011 to 2030, CAA.
- [3] Safety Assessment Made Easier, Part 1 – Safety Principles and an Introduction to Safety Assessment, Edition 1.0, 15th January 2010.
- [4] Safety Case Development Manual Edition 2.1, Eurocontrol, 13 October 2006.

Abbreviations

2.2 The following abbreviations are used throughout this document.

ALARP	As Low as Reasonably Practicable
ATCSMAC	ATC Surveillance Minimum Altitude Chart
ASR	Altimeter Setting Region
CACC	Civil Aviation Communication Centre
CAT	Commercial Air Transport
CAS	Controlled AirSpace
CFIT	Controlled Flight Into Terrain
CONOP	CONcept of OPERations
DFL	Divisional Flight Level
EASA	European Aviation Safety Agency
FAB	Functional Airspace Block
FAS	Future Airspace Strategy
FASDSG	Future Airspace Strategy Deployment Steering Group
FASPRPB	Future Airspace Strategy Policy and Regulatory Programme Board
FMS	Flight Management System
GA	General Aviation
GAT	General Air Traffic

GNSS	Global Navigation Satellite System
GSN	Goal Structured Notation
HETA	Harmonised European Transition Altitude
IAA	Irish Aviation Authority
ISR	Interim Safety Report
LAMP	London Airspace Management Programme
LFP	Lowest Forecast Pressure
MAC	Mid Air Collision
MOC	Minimum Obstacle Clearance
MOCOR	Maturity of Cross Organisational Relationships
MOD	Ministry of Defence
NASAS	Nominated Altimeter Setting Aerodrome or Station
NTCA	Northern Terminal Control Area
OAT	Operational Air Traffic
RMG	Rule Making Group
RNAV	Area Navigation
RPS	Regional Pressure Setting
RTF	Radio Telephony
SARG	Safety and Airspace Regulation Group
SERA	Standardised European Rules of the Air
SID	Standard Instrument Departure
SPS	Standard Pressure Setting
SSAR	State Safety Assurance Report
SSC	Single Sky Committee
STAR	STandard Arrival Route
TA	Transition Altitude
TAPT	Transition Altitude Project Team
TASC	Transition Altitude Safety Committee
TASG	Transition Altitude Steering Group

TMA	Terminal Manoeuvring Area
ToR	Terms of Reference
VSM	Vertical Separation Minima

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3 System Description

- 3.1 The UK currently operates a variety of TAs that are based upon local operational requirements and have changed over time and thus vary across the country. The TA at most major airports in the UK is 6 000 ft amsl, whilst in the Manchester Terminal Manoeuvring Area (TMA) area it is 5 000ft amsl. At most minor aerodromes and for most uncontrolled airspace the TA is 3 000 ft amsl. The current situation has the potential to result in altimeter setting errors in terms of when the Standard Pressure Setting (SPS) should be applied. Moreover, in Class G airspace, these relatively low TAs can result in pilots operating above the TA without setting their altimeter to the SPS. This requires them to calculate their vertical position in relation to CAS with a base defined as a FL whilst in cockpit, a procedure open to human error.
- 3.2 Outwith the lateral boundaries of Controlled Airspace (CAS)⁷, the UK has been divided into a number of Altimeter Setting Regions (ASRs), for each of which the UK Met Office calculates the lowest forecast QNH for any point within the Region for each hour; this is known as the Regional Pressure Setting (RPS). Thus, when used in conjunction with an appropriate cruising level, the RPS guarantees terrain clearance and safe overflight of airspace reservations. However, the RPS system excludes airspace below all Terminal Control Areas (TMAs), Control Areas (CTAs) except Airways and the Worthing and Clacton Control Areas, during their notified hours of operation
- 3.3 With the intention of safely enhancing efficiency throughout UK airspace through the standardisation of airspace and altimeter setting procedures, and in order to enable future airspace projects, a harmonised, raised UK TA of 18 000ft has been agreed. This change will be complemented by the replacement of the existing ASR based upon the RPS system, with newly defined ASRs that will use an 'actual' QNH. Each ASR will have a Nominated Altimeter Setting Aerodrome or Station (NASAS), from whose METAR the ASR QNH will be derived and promulgated in a half-hourly ASR Bulletin (see map of proposed ASRs at Annexe B). In addition, for those areas where there is no capability to produce an actual QNH, such as the area North of the Outer Hebrides, and in order to maintain overall system integrity, the UK Met Office will provide a 'predicted actual' ASR QNH per NASAS. These 'predicted actual' values will not be apparent to, and have no impact upon, the user.
- 3.4 The proposed change will have wide ranging implications for every facet of the UK's ATM system and, indeed, how that system interacts with the wider European and international ATM system. As such, the proposed changes introduce threats and opportunities that must be mitigated or exploited.
- 3.5 The UK TA Project was established in order to deliver a harmonised UK TA and the associated revised system of ASRs. One of the key deliverables of the project is the UK State TA CONOP document which describes the high-level characteristics for the proposed TA in UK airspace and should be considered as the baseline for the evaluation of procedures to be used. Moreover, through the auspices of the UK/Ireland/Norway TA Oversight Group (UINTAOG), the Irish State CONOP document has been developed in parallel with the UK State CONOP to ensure that, where appropriate, there is commonality of procedures and principles.

⁷ UK AIP ENR 1.7 3.9 states that airspace within all Control Zones (CTRs), and within and below all Terminal Control Areas (TMAs) and Control Areas (CTAs) except Airways and the Worthing and Clacton Control Areas, during their notified hours of operation, does not form part of the ASR RPS system.

4 Overall Safety Argument

Objectives

4.1 The objectives of this section are to:

- Outline the overall top-level safety argument for the harmonised UK TA.
- Present and explain the supporting argument structure and related context and justification.
- Explain the decomposition of the safety argument.

4.2 The overall safety argument is presented in Figure 1 below, using Goal Structuring Notation (GSN) – Annexe C provides a key for the GSN. Colour coding is used within the GSN to indicate progress in delivering specific elements of the safety argument. **GREEN** indicates that the goal has been satisfied. **AMBER** indicates that work to satisfy a goal, or deliver a piece of evidence/solution has begun but is not yet complete. **RED** indicates that work has not yet begun on satisfying a goal, or providing specific evidence/solutions. Consequently, it can be seen that for a goal to become **GREEN**, all sub-elements beneath that goal must also be **GREEN**. Where sub-elements are a mixture of **RED**, **AMBER** and **GREEN**, a subjective assessment was made on the status of the higher goal and then validated through peer review. In interpreting the colour coding of the GSN, it is important to bear in mind that the GSN relates to all of the work required to design, implement and maintain the operation of a raised TA. Consequently, it is reasonable that, at this stage of the Project, there will be elements of the GSN coded **RED** and **AMBER**.

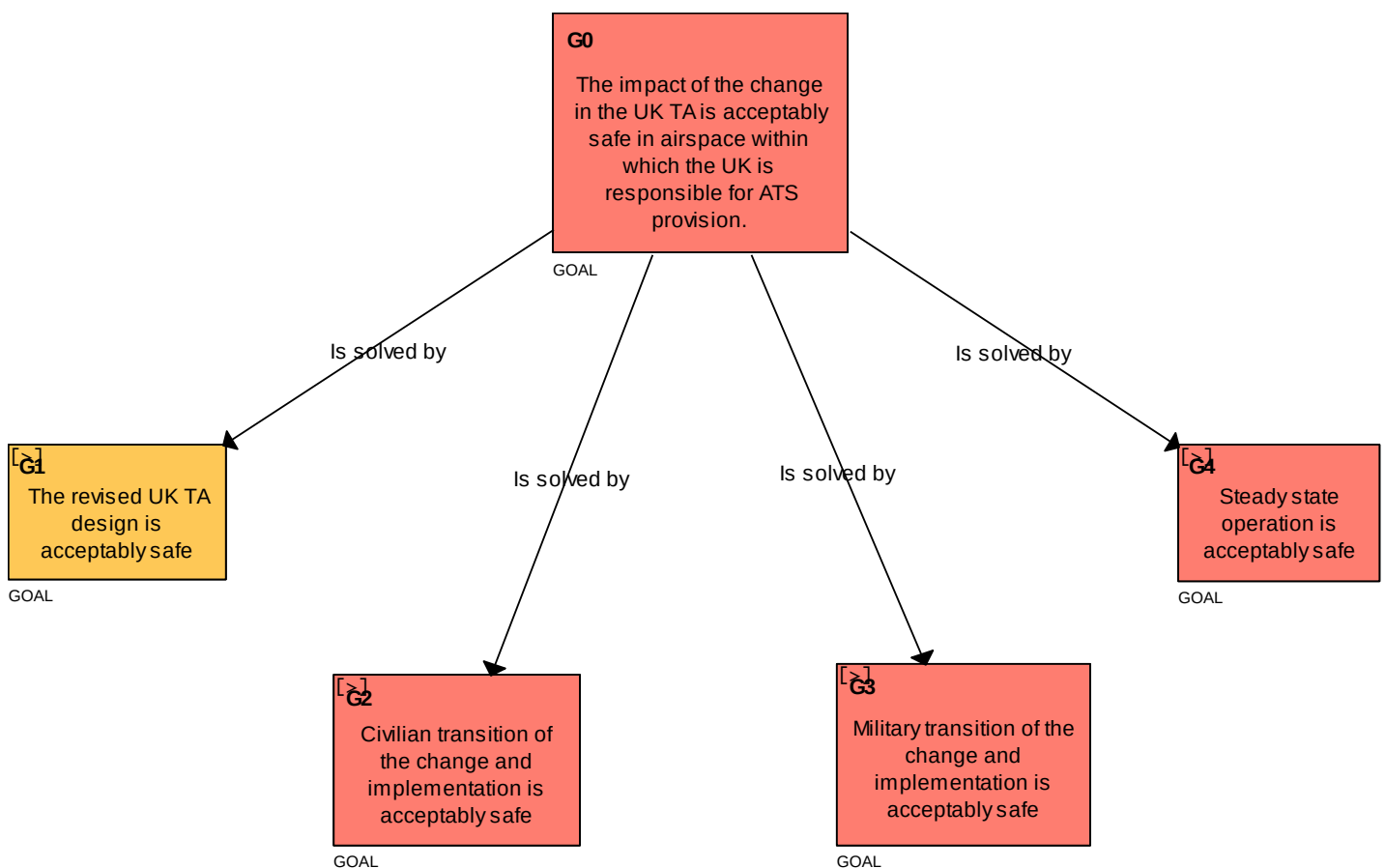


Figure 1: Harmonised UK TA Overall Safety Argument

The Safety Argument

- 4.3 The justification for the introduction of a harmonised UK Transition Altitude of 18 000ft is that it will enhance efficiency, both inside and outside controlled airspace, through the standardisation of airspace and altimeter setting procedures. This will provide the foundation for future safety, environmental and economic benefits that will be realised through improvements to the vertical profiles of aircraft arrivals and departures in the London and Scottish FIRs. It also serves as a platform for future airspace and operating concepts through programmes such as SES, SESAR, FAS, UK/Ireland FAB, the LAMP and the NTCA Development Plan.
- 4.4 The aim of the SSAR is to provide assurance to support the goal (**G0**) that 'the impact of the change in the UK TA is acceptably safe, in airspace within which the UK is responsible for ATS provision'. This claim is subject to any stated identified issues, assumptions and limitations and is made within the context that:
- a. airspace within which the UK is responsible for ATS provision means:
 - (i) UK FIRs (excluding where ATS provision is delegated to other states).
 - (ii) Airspace in non UK FIR where ATS provision is delegated to the UK.

This shall also address the boundary interfaces between UK and non UK ATS provision.
 - b. all changes are justified on the grounds that they will directly reduce the risk, and/or contribute, to the development of a fundamentally safer system or at the very least maintain current levels of safety whilst delivering benefits in other areas⁸.
- 4.5 **Safety Criteria.** The acceptable level of safety in **G0** is defined by the safety criteria (**C1.5**). These are that 'Acceptably Safe' is considered to mean that risks are acceptable, or tolerable and mitigated to ALARP, and that there is no unacceptable risk. However, the concept of 'acceptably safe' must then be considered against the overriding FAS requirement outlined in paragraph 4.4 b above. Therefore, the goal (**G0**) will be expressed wholly in terms of 'relative' and 'reductive' safety criteria.

Strategy for Decomposing the Safety Argument

- 4.6 The overall goal (**G0**) is decomposed into four principle safety arguments as indicated in Figure 1. The decomposition of **G0** is based on the Generic Argument presented in EUROCONTROL's Safety Assessment Made Easier [1]. The strategy for satisfying **G0** is thus to demonstrate that:
- a. The revised UK TA design is acceptably safe (**G1**).
 - b. The civilian and military transition of the change and implementation is acceptably safe (**G2** and **G3** respectively).
 - c. The steady state operation is acceptably safe (**G4**).
- 4.7 Although work has commenced on considering the timelines and tasks associated with the implementation of a harmonised, raised TA (**G2**, **G3** and **G4**), the focus of the UK State TA Project has been those activities related to satisfying **G1**. Further activity to address **G2**, **G3** and **G4** is scheduled to commence in late 2015 following the initiation of the 2nd State consultation; thus no assessment can be made regarding overall progress towards satisfying

⁸ CAA Future Airspace Strategy for the UK 2011 to 2030.

G0. The primary function of this SSAR is to explain why the revised UK TA design is acceptably safe and thus satisfy **G1**.

5 The Revised UK TA Design is Acceptably Safe

Objective

- 5.1 The objective of this section is to support the goal that the revised UK TA design is acceptably safe. The argument is made within the context that the TA design is summarised by the State CONOP and supporting State level procedures and includes the specific altitude chosen, the altimeter setting procedures, and any associated flight crew and ATS procedures and processes that are new, or changed, as a result of the revised TA.

Strategy

- 5.2 In order to satisfy the goal (**G1**), it was necessary to decompose it further into a series of sub-goals. This was achieved by following 3 strategies which were designed to demonstrate that:
- a. Safety has been appropriately addressed in the State TA Safety Project Design Phase (**S1.1**).
 - b. The specific TA chosen and the related ASR designs are acceptably safe (**S1.2**); and
 - c. The State airspace, flight crew and ATC procedures are acceptably safe (**S1.3**).
- 5.3 The overall safety argument that the revised UK TA design is acceptably safe is presented in Figure 2 overleaf. The individual arguments that are presented in Figure 2 are addressed in turn in the following sections and the evidence used to support them discussed.
- 5.4 The elements of the safety argument relating to the choice of the TA, the ASR design and the proposed State airspace, flight crew and ATC procedures follow a pattern whereby a goal is considered to be acceptably safe when it can be demonstrated to have become 'known' having 'evolved' and been 'baselined'⁹ and then subsequently 'validated'¹⁰. However, it is important to consider that the use of the term 'validation' in this context means that the State is utilising evidence drawn from analyses conducted by the joint partners and through pre-consultation engagement with aviation stakeholders to validate concepts related to the raised TA. There is not necessarily a direct correlation between the State's use of 'validation' and that of one of the joint partners.

⁹ 'Baselined' is taken to mean that a decision has been made and accepted by all parties involved.

¹⁰ 'Validated' is taken to mean that the concept or premise has been tested by some means and that the results of that testing have been deemed acceptable by all parties involved.

Safety has Been Appropriately Addressed in the State TA Safety Project Design Phase

- 5.5 Through **S1.1**, a series of further sub-goals were identified to ensure that the Project utilised an appropriate safety methodology and developed sufficient evidence for safety assurance purposes; this is depicted in Figure 3 below.

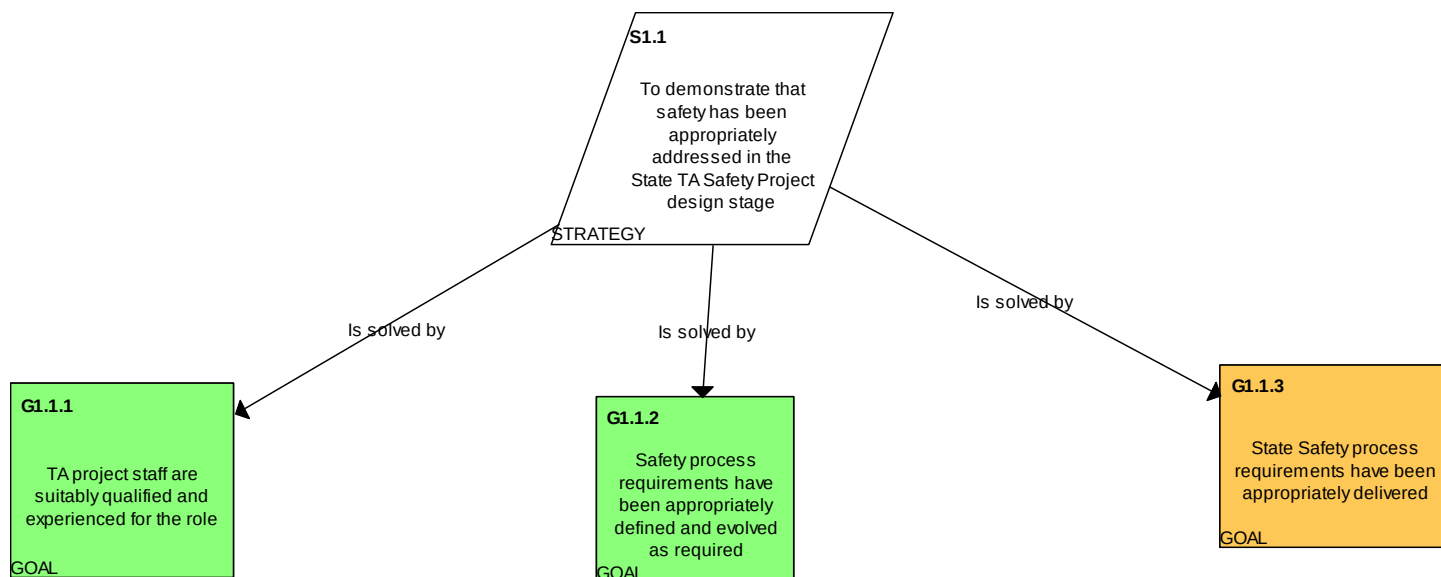


Figure 3: Safety has Been Appropriately Addressed in the State TA Safety Project Design Phase (S1.1)

- 5.6 **TA Project Staff are Suitably Qualified and Experienced for the Role (G1.1.1).** Three project fora were established to provide governance for the UK TA project¹¹:
- TA Steering Group (TASG).** Reports to the FAS Policy and Regulatory Programme Board (PRPB) and is accountable for the safe and effective implementation of a revised TA and oversees and supervises the delivery of the TA project.
 - TA Safety Committee (TASC).** Responsible to the TASG for the coordination of cross-project safety activity and for ensuring appropriate safety assurance exists to support the UK TA change and its implementation. Key outputs from the TASC are the State's TA Project Safety Risk Register and Safety Argument GSN.
 - TA Project Team (TAPT).** Responsible to the TASG for delivering the safe and effective implementation of a revised TA, through the production of specific deliverables and milestones, in accordance with the agreed timescale. A key output from the TAPT is the UK State TA CONOP document.
- 5.7 Staff for the UK TA Project that sit within these fora are drawn from the 3 joint project partners – NATS, MOD and the UK CAA – and comprise personnel with operational, project management and safety management expertise from within the ATM¹² and flight crew spheres. Evidence that these individuals are suitably qualified and experienced personnel (SQEP) to fulfil their role within the TA Project is recorded, whilst evidence of their attendance at Project fora exists in records of meetings. Moreover, where it has been identified that specific knowledge or expertise is required that is outwith the skill-set of project staff, for example the provision of modelling to assess the impact of a QNH tolerance¹³

¹¹ UK TA Project terms of reference dated July 2015.

¹² Includes Safety Engineers, ATCOs, Airspace Specialists and Systems Engineers.

¹³ A concept where a variance between aircraft altimeter settings, or between an aircraft altimeter setting and the specified CAS pressure datum, is tolerated to exist within the ATM system, up to a specified magnitude.