The Second UK State Consultation on a Harmonised Transition Altitude (TA):

SSAR - State Safety Assurance Report

CAP 1349 - 8

Harmonised Transition Altitude in the London and Scottish Flight Information Regions

State Safety Assurance Report

DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

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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 safe[1], 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 transitionary 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 procedures[2]. 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 safe[3], 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 ATM[4] 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 requirements[5]. 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 system[6]; 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

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.

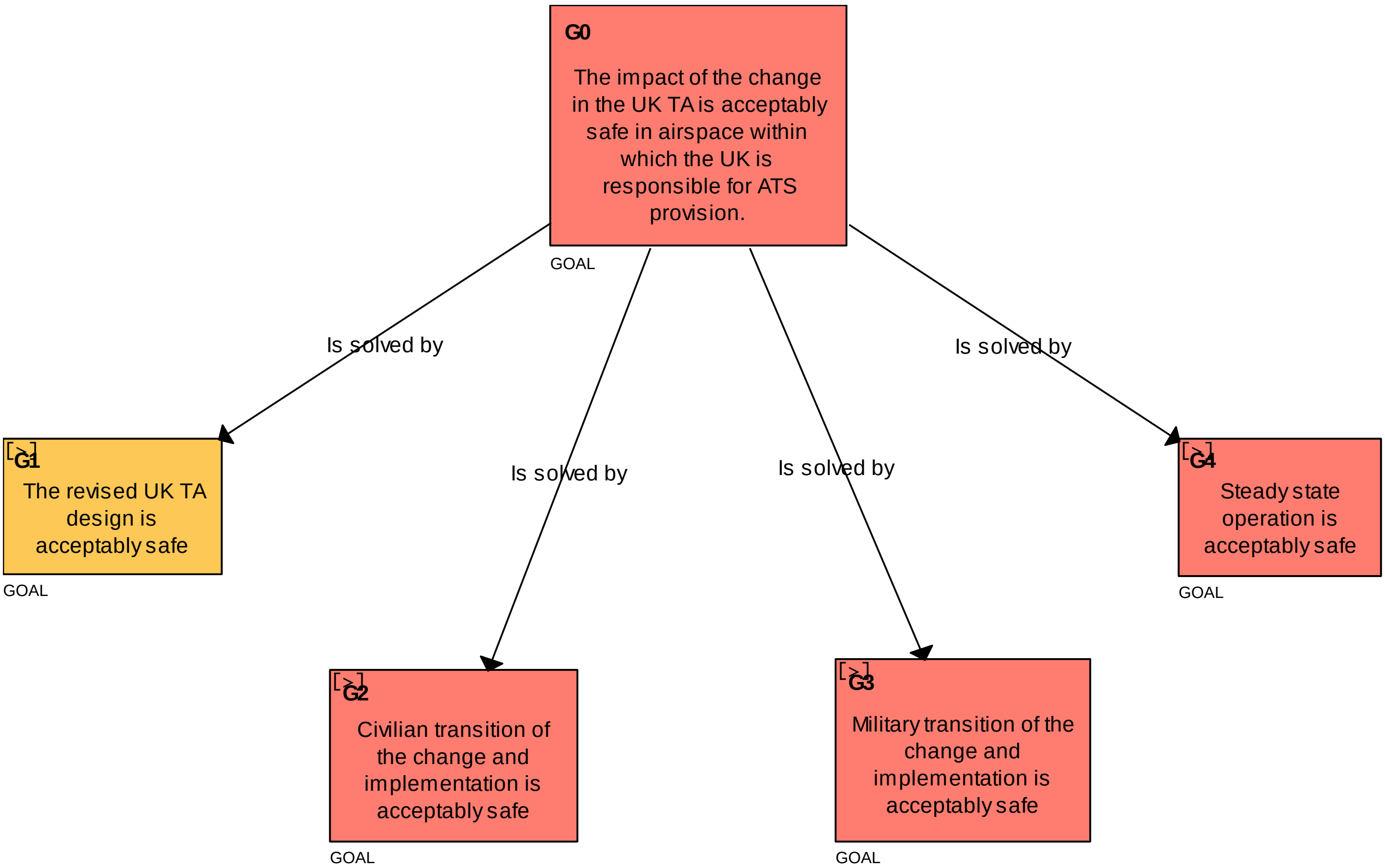

Figure 1: Harmonised UK TA Overall Safety Argument

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 areas[8].

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.

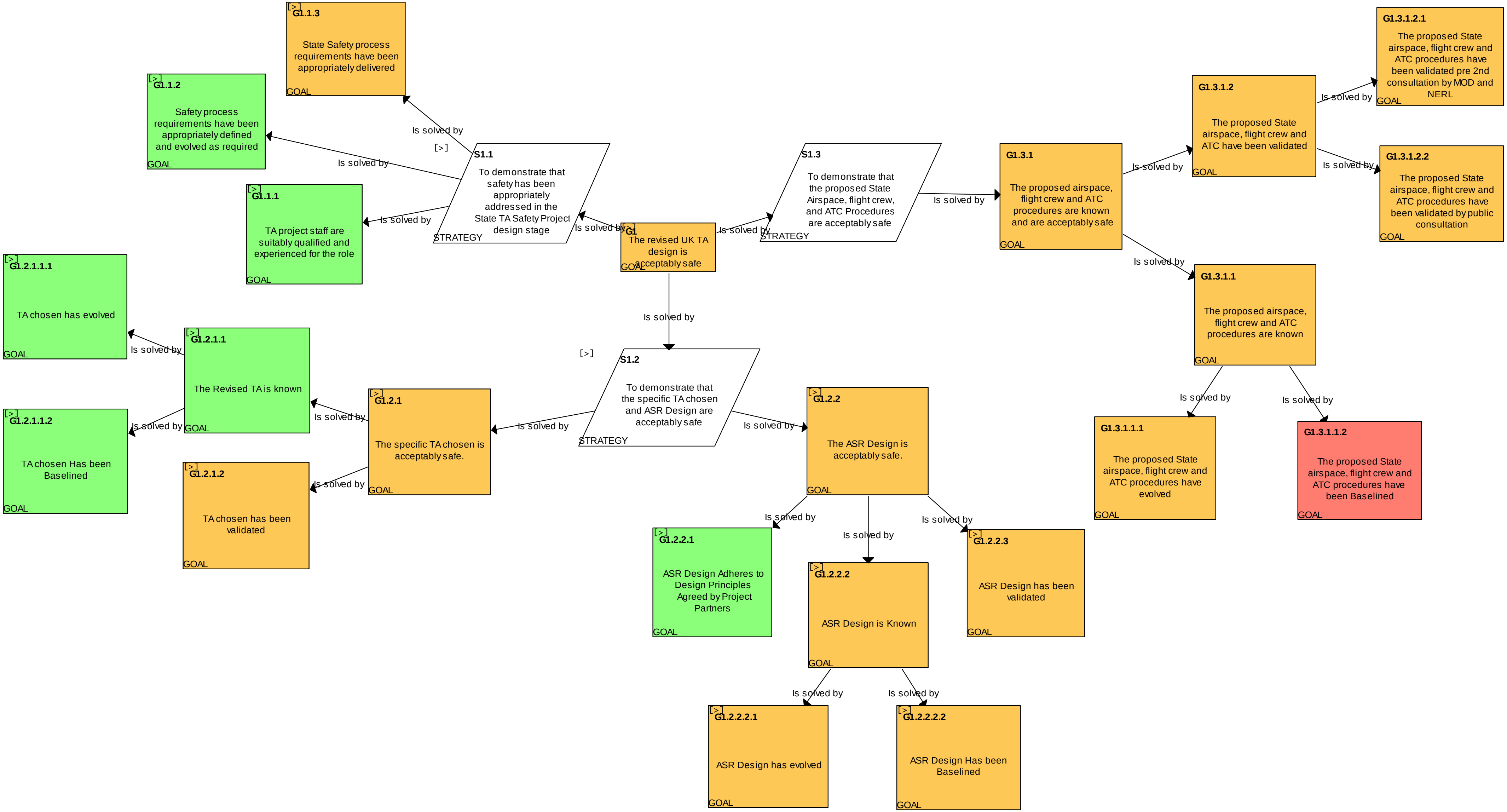

Figure 2: UK TA Design is Acceptably Safe (G1)

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.

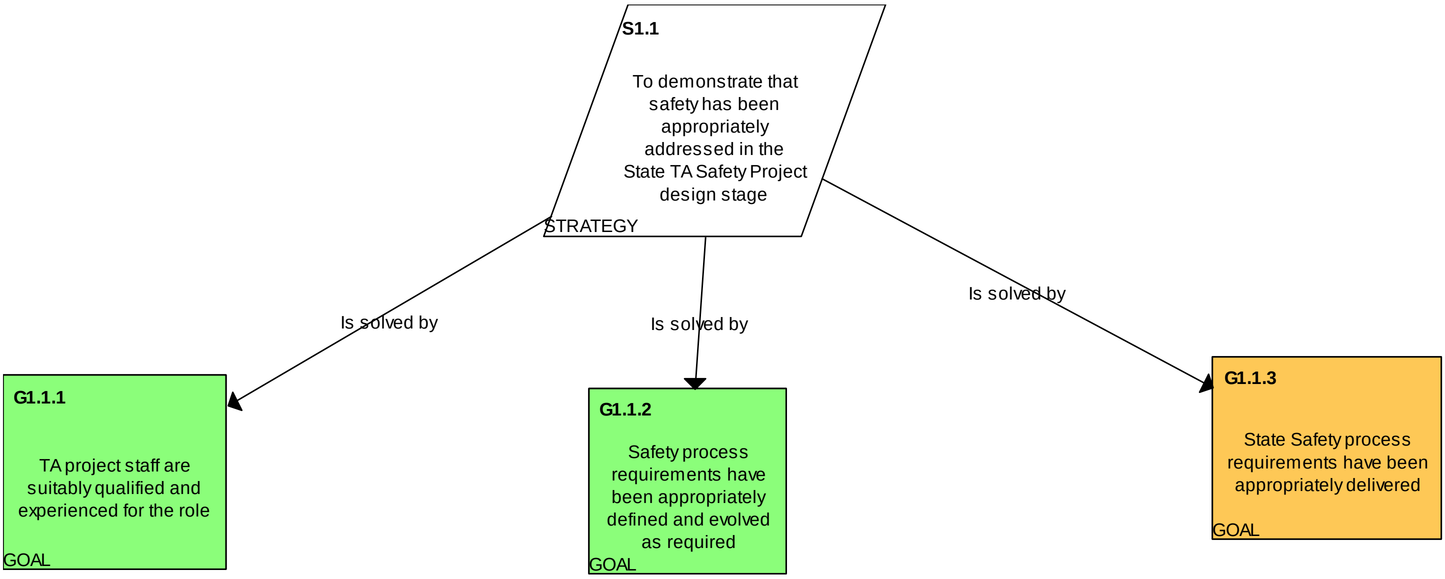

Figure 3: Safety has Been Appropriately Addressed in the State TA Safety Project Design Phase (S1.1)

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 project[11]:

a. **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.

b. **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.

c. **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 ATM[12] 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 tolerance[13]

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[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.

concept on TCAS, the project has engaged with the appropriate agencies. Sufficient evidence exists of this type of activity within the project records. Taken together, these satisfy **G1.1.1**.

5.8 **Safety Process Requirements Have Been Appropriately Defined and Evolved as Required (G1.1.2).** The 'Safety Approach' adopted by the project, the safety criteria (**C1.5**) and the evidence needed to satisfy the safety assurance requirements of the project were defined and directed within the State TA Safety Plan and the Terms of Reference (ToR) derived for project working groups. The first iteration of the State TA Safety Plan was published in July 2012 and was updated in March 2013 following the creation of the TA Safety Committee (TASC) and as safety requirements became clearer. In March 2014, the Safety Plan was subsumed within a set of ToR published by the TASG which clearly articulates the safety responsibilities of the project's working groups and the safety deliverables for which each group was responsible. Taken together, these satisfy **G1.1.2**.

5.9 **State Safety Process Requirements Have Been Appropriately Delivered (G1.1.3).** As might be expected given that the project is advancing towards the 2nd Consultation phase, the process of producing the safety deliverables remains iterative and includes the development of the:

a. **State TA Safety Risk Register.** The State TA Safety Risk Register was established in 2013 to collate safety risk analysis work conducted by the project partners and to ensure that these risks were clearly differentiated from Project risk[14]. Separate focal areas were established within the register for risks related to CAS, Class G airspace, TA implementation activities and 'general' safety risks; these being either generic across UK airspace and in existence prior to implementation, or resultant from proposals within the evolving CONOP. The Safety Risk Register is a living document that has developed from version 0.1 to its current iteration, version 2.0 by ensuring that it is aligned with and updated from risk analysis work undertaken by NATS and MOD and through CONOP development undertaken by the joint project. Safety risk is discussed further in Section 8.

(i) **Version 1.0.** The first significant revision of the safety risk register was published with the Interim Safety Report (ISR – see paragraph 5.9 c (i)) in October 2014 and was preceded by a 'gap analysis' comparison between the safety work undertaken by the joint project partners and the pre-existing safety risk register, in order to determine the sufficiency of the work conducted to date and to identify additional work required to mitigate the identified safety risks. Following peer review and agreement between the TAPT and TASC, this enabled links to be established between the Project Safety Risk Register and the TAPT Actions Log, both to support the audit trail within the project and to provide an action owner for the development of the risk mitigation.

(ii) **Version 2.0.** The second major revision to the safety risk register will be published to support this SSAR. A significant amount of progress in concept development has been made since the publication of the ISR in October 2014 and this has been reflected in changes to the Safety Risk Register.

b. **State Safety Argument GSN.** Whilst the creation of the GSN has been led by the State, a collaborative review and refinement process has been adopted by the joint project partners in order to ensure that appropriate safety assurance exists to support the UK TA change and its implementation. This has also provided validation that both NATS and MOD can identify how their own internal safety processes link into this

[14] Project Risk is defined by the Office of Government Commerce as 'an uncertain event or set of circumstances that, should it occur, will have an effect on achievement of one or more objectives'. Safety Risk is defined by ICAO (Doc 9859) as the 'assessed potential for adverse consequences resulting from a hazard. It is the likelihood that the hazard's potential to cause harm will be realised'.

overarching safety argument. This SSAR is a textual representation of the State Safety Argument GSN.

c. **Safety Assurance Reports.** In defining the safety assurance requirements for the Project, the TASG directed that an Interim and a final Safety Assurance Report would be produced by the TASC.

(i) **Interim Safety Report (ISR).** The ISR was published by the TA Safety Committee in October 2014 and was developed in collaboration with all project partners. It reviewed the progress that had been achieved in developing Project safety assurance and made a number of recommendations to put in place actions which would ensure that the public consultation on the CONOP had robust safety evidences and rationale. Importantly, the TASG's endorsement of the ISR validated both the structure of the safety argument itself, and the TASC's approach to providing assurance to support the goal (**G 0**) that 'the impact of the change in the UK TA is acceptably safe, in airspace within which the UK is responsible for ATS provision'.

(ii) **State Safety Assurance Report (SSAR).** This SSAR will be delivered to the TASG on 30 September 2015 following endorsement and approval by the TAPT, TASC and CAA SARG.

5.10 Understandably, given that they are, as stated previously, part of an iterative process, activity to develop these safety process requirements and thus satisfy **G1.1.3** will continue. However, it is reasonable to argue that, at this stage in the Project's lifecycle, an acceptable level of maturity exists within these documents and that they are being used to focus and direct Project activity.

5.11 **Summary – Safety has Been Appropriately Addressed in the State TA Safety Project Design Phase.** Based upon the evidence, it is reasonable to argue that safety is being appropriately addressed within the project. The project utilises suitably qualified and experienced personnel, 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.

The Specific TA Chosen and ASR Design are Acceptably Safe

5.12 Through **S1.2**, a series of further sub-goals were identified to ensure that the specific TA chosen and the ASR design were acceptably safe; this is depicted in Figure 4 below.

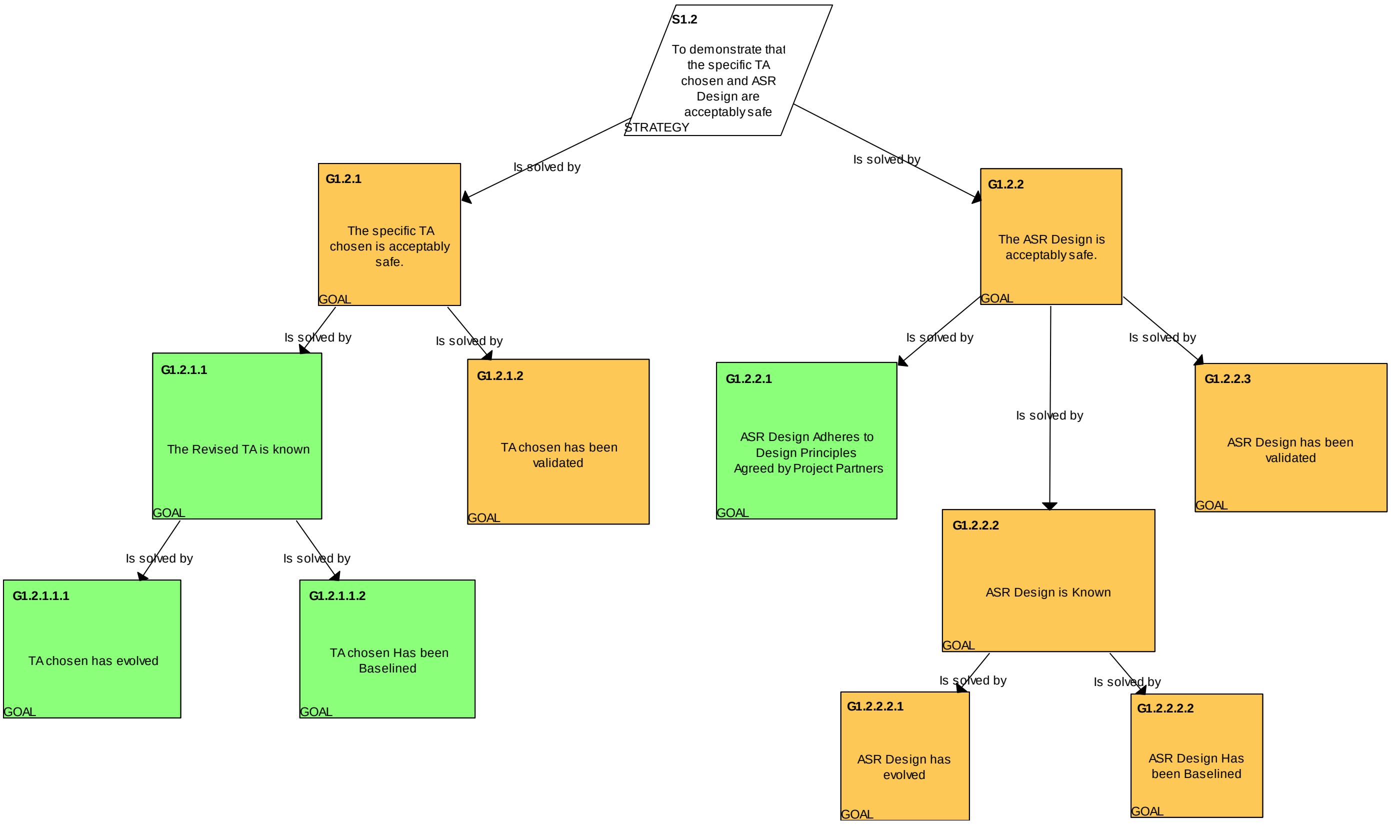

Figure 4: The Specific TA Chosen and ASR Design are Acceptably Safe (S1.2)

The Specific TA Chosen is Acceptably Safe (G1.2.1)

5.13 The Revised TA is Known (G1.2.1.1). It is widely recognised throughout Europe that the harmonisation of the TA and associated procedures have the potential to bring safety benefits through the simplification of airspace and procedures. This is in line with International Civil Aviation Organisation (ICAO) direction which advocates the implementation of a common TA for each ICAO Region[15]. As early as 2004, the European Action Plan for Level Busts issued a recommendation to consider the establishment of a common European TA in order to minimise the possibilities of level busts/altitude deviations in Europe. Subsequent safety analysis work conducted within the UK highlighted the challenges involved in enabling SIDs to a Flight Level (FL) in high density/complexity airspace[16] and thus provided further impetus to the requirement for an increased TA. Consequently, in around 2009, the UK/Ireland Functional Airspace Block (FAB), through the Future Airspace (FAS) Policy and Regulatory Programme Board (FASPRPB) undertook to develop and implement a harmonised, raised, TA throughout FAB airspace. The purpose of this raised TA being to act as a foundation for future improvements to the vertical profiles of aircraft arrivals and departures in the London and Scottish FIRs.

5.14 Harmonisation of the TA is also a SES and SESAR objective and as such, in 2013, the European Aviation Safety Agency (EASA) established a HETA Rule Making Group (RMG) whose objective was to identify regulatory solutions that would determine 'whether and how

[15] ICAO Doc 8168 PANS-Ops Volume 1 2.1.2.3.
[16] This was briefed by NATS at FAS TA Industry Forum 14 June 2013.

best to improve safety via harmonisation of TA applied across Europe'[17]. However, the UK recognised that the work of the RMG and any subsequent decision by the Single Sky Committee (SSC) would not enable the implementation of a HETA within the timescale required by the UK to enable the FAS[18]. Thus the UK undertook to continue to pursue a harmonised, raised TA within the FAB, whilst ensuring that we continued to engage with aviation authorities and ANSPs within adjacent states on the path and merits of the FAB's course of action.

5.15 Much of the early evolution of the TA chosen by the UK was as a result of work conducted by NATS - in partnership with the UK CAA and MOD – to determine the optimum altitude to facilitate future airspace and operating concepts. This included safety assessment activity designed to obtain and analyse quantitative data in support of qualitative assessments that were made of the impact of a raised TA between 14 000 ft and 18 000ft in key sector groups within airspace controlled from both Swanwick (Terminal and Area Control) and Prestwick Centres[19]. This culminated in a Public Consultation[20] which was initiated in January 2012 by the UK CAA and proposed a case for a raised TA of 18 000ft over lesser altitudes and the option of maintaining the UK's current method of operations. Along with the operational benefits associated with a TA of 14 000 ft or above, one of the reasons for the specific selection of 18 000ft, in preference to a lesser value, was in order to mitigate the risk posed to the UK by any future decision by EASA on a HETA. By implementing a raised TA of 18 000ft, the UK would thus be in a position to satisfy either option '2' or '3'; rather than implement the lowest suitable TA for the UK and risk EASA proposing an IR on 18 000ft, necessitating a second change in the UK's TA. Albeit a brief resume of events, the above explains how the UK's 'choice' of the proposed TA of 18 000 ft evolved in response to demands placed upon it by the requirement for increased capacity within UK airspace and by external regulatory considerations and thus satisfies **G1.2.1.1**.

5.16 A decision to baseline the proposed TA of 18 000 ft was taken on 19 December 2013 by the FAS Deployment Steering Group (DSG). This followed an endorsement by the FAS PRPB on 5 December 13 of a briefing paper by the TASG[21], which provided the high level rationale behind the TASG's recommendation of this value as the preferred level for a raised UK TA. The UK's decision received further support in early 2014 from a letter signed by the UK CAA, Irish Aviation Authority (IAA), Isle of Man CAA and the Norwegian CAA[22] stating their intent to "…cooperate fully on the development and implementation of a higher TA, nominally 18 000 ft, for deployment as soon as practicable within a mutually agreed timescale." In summary, these satisfy the goal that the chosen TA has been baselined (**G1.2.1.2**), thus providing an unambiguous UK State position on which further project activity has been based.

5.17 <u>TA Chosen has Been Validated (G1.2.1.2).</u> The UK State TA Project believes that a TA of 18 000 ft can be validated by determining that it satisfies the requirements of the airspace user community, whilst ensuring that the proposed State airspace, flight crew and ATC procedures associated with the TA of 18 000 ft are acceptably safe. Thus, assessment of the procedures and processes associated with a TA of 18 000 ft will, by inference, test the selection of that value as the UK/Ireland FAB TA. In order to inform the decision to initiate consultation, the State has conducted a measure of pre-consultation validation activity. This has taken into account separate analyses by NATS and MOD (which include safety assessment and ATM simulation of the concepts), and engagement with stakeholders

[17] Terms of Reference ATM.021(a) (RMT.0585) & ATM.021(b) (RMT.0407).
[18] The HETA RMG concluded in December 2014 that there should be no regulatory intervention, although it felt that EASA should issue guidance to States wishing to change their TAs in the future. At the time of writing, these findings had been presented to the European Commission, ahead of their presentation to the SSC for ratification.
[19] As highlighted in brief from Head of Swanwick ATM Development and Delivery September 2012.
[20] Consultation on the Policy to Introduce a Harmonised TA of 18 000 ft in the London and Scottish FIRs dated January 2012.
[21] Paper to Inform the FAS PRPB ahead of the State Decision on the Chosen Altitude for a Higher and Harmonised TA Across UK and UK/Ireland FAB Airspace; colloquially known as the '5-Threads'.
[22] Letter of Intent 'Higher Regional Transition Altitude' between the IAA Safety Regulation Division, the UK CAA and other Neighbouring European NSAs wishing to Adopt the same Higher Regional Transition Altitude'. Signatures were appended to the letter between 28 January 2014 and 12 February 2014.

outwith the Project partners but affected by the raised TA; for example, non-NATS ANSPs and pilots from the commercial as well as recreational aviation communities. Whilst this engagement has been sought without prejudice to the subject organisation's ability to comment on the 2nd State Consultation, it serves to de-risk that consultation by allowing the project to mature collaboratively. The final evidence to satisfy the goal that the TA chosen has been validated (**G1.2.1.3**) will be the result from that 2nd consultation, where all UK aviation stakeholders will have the opportunity to provide formal comment on all aspects of the proposal.

5.18 **Summary.** In terms of progress towards satisfying **G1.2.1**, we can state that one of the two sub-goals (**G1.2.1.1**) has been satisfied. However, as mentioned previously, the final validation of the TA chosen will be inferred through the validation of the ASR design (**G1.2.2.3**) and the proposed State airspace, flight crew and ATC procedures (**G1.3.1.2**) and from the outcome of the 2nd State Consultation in February 2016. Moreover, the ASR design and proposed State airspace, flight crew and ATC procedures may be refined in light of consultation responses and thus it is not possible to argue, at this time, that **G1.2.1.2** has been satisfied. Consequently, in terms of demonstrating that the chosen TA has been validated (**G1.2.1.2**) and, in turn, it is acceptably safe (**G1.2.1**), we must assess and rely upon the strength of the safety assurance evidence that exists to support **G1.2.2.3** (paragraphs 5.33 to 5.37) and **G1.3.1.2** (paragraphs 5.44 to 5.46).

The ASR Design is Acceptably Safe (G1.2.2)

5.19 Through **G1.2.2**, a series of further sub-goals were identified to ensure that the ASR design was acceptably safe; this is depicted in Figure 5 below.

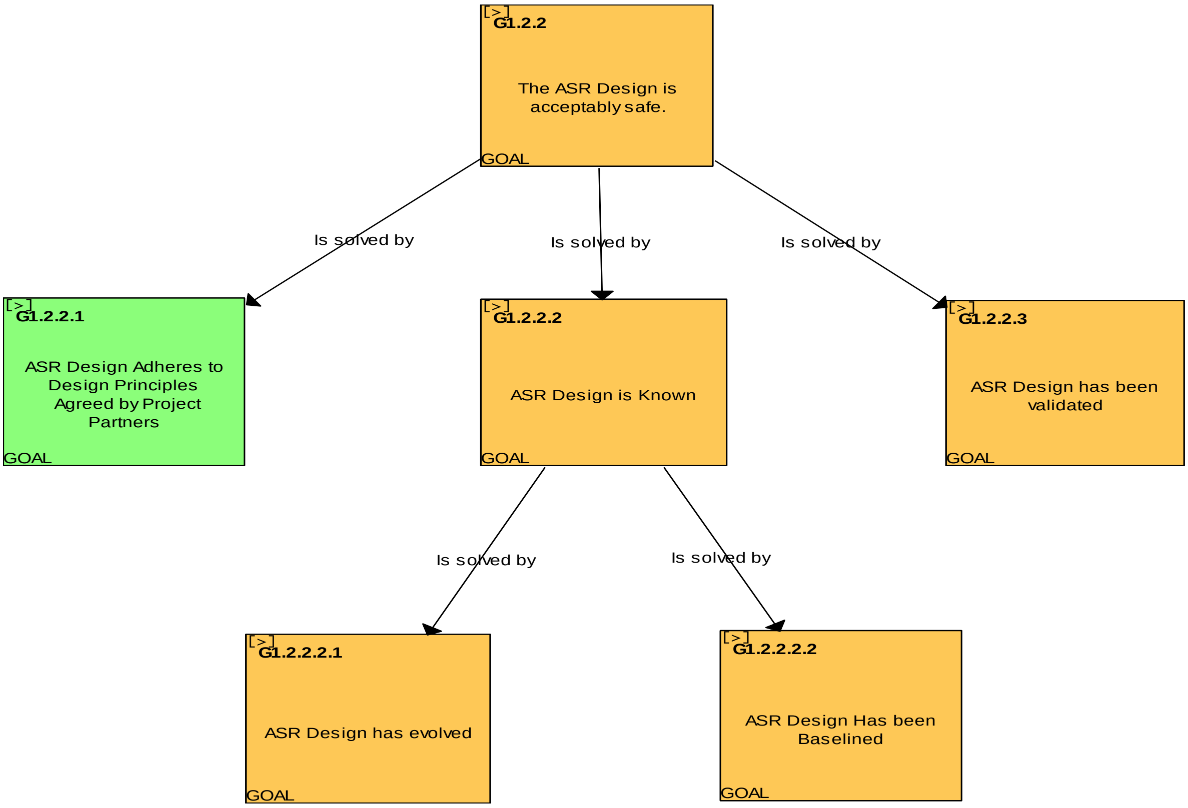

Figure 5: The ASR Design is Acceptably Safe (G1.2.2)

5.20 <u>ASR Design Adheres to Design Principles Agreed by Project Partners (G1.2.2.1).</u> The ASR design principles for UK airspace were derived following a series of meetings between project stakeholders, which included the UK Meteorological Authority, and were later informed by the development of procedures for the use of an ASR QNH. Importantly, to ensure commonality of approach across the FAB, a number of meetings were also held with Met Eireann[23] and the Irish Aviation Authority (IAA). Together, these initial meetings examined a range of potential solutions[24] for the replacement of the RPS within the UK, some of which were detailed in the CAA's first 'Consultation on the Policy to Introduce a Harmonised TA in January 2012 and were considered in the light of data provided by the UK Met Office[25]. That 1st State Consultation outlined 4 implementation options which could be used as a basis for development of future altimeter setting procedures. This included options to use either 'lowest forecast' or 'actual' QNH values, the advantages and disadvantages of each, with the latter proposal receiving significant support[26] from those stakeholders who responded to the consultation. The joint project thus settled on the concept of utilising actual rather than lowest forecast QNH values to define new ASRs. These actual QNH values will generally be derived from the METAR of a Nominated Altimeter Setting Aerodrome or Station (NASAS), collated and then issued by the Civil Aviation Communication Centre (CACC) on a half-hourly basis as an ASR Bulletin. However, normally, when an aerodrome QNH is observed to change by 1hPa outside of the METAR cycle, it is a requirement for the aerodrome to update the aerodrome QNH through a Local Special Report (SPECI). However, where this occurs at a NASAS, this will not be promulgated as an ASR bulletin in order to minimise the effect on workload to pilots and ATS personnel caused by multiple pressure changes. Where a METAR is not issued by a NASAS, or the METAR does not contain a valid[27] QNH, or where there is no capability to provide a METAR, such as from the DONALD ASR, the UK Met Office will provide a predicted ASR QNH value. These predicted values will not be apparent to and have no impact upon the user, and contingency arrangements will be established by the CACC and the UK Met Office.

5.21 Originally, the RPS system was devised to make up for a short-fall within the UK of stations with the capability to report actual QNH values H24. However, an increasing number of stations now have the capability to do this and, where this is not possible, as previously stated, the UK Met Office has the ability to predict an actual QNH value. Moreover, given that the RPS is the lowest forecast pressure expected within an ASR over the period of an hour, the RPS can lead to significant variations between the RPS of adjacent ASRs and between the RPS and the QNH of an aerodrome within the same ASR. Variations in excess of 30 hPa between the RPS of adjacent ASRs have been observed, equating to a vertical difference in position of approximately 1 200 ft. It is reasonable to argue that it was the risk of airspace infringement resulting from these large variances which, in part, determined that the RPS system excluded 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[28].

5.22 The adoption of an 'actual' QNH value that is promulgated for a specific volume of CAS (described in paragraph 5.42 c and d) will ease the task of ATS personnel and flight crews in avoiding infringement of CAS. Furthermore, the adoption of actual QNH values would bring the UK's altimeter setting procedures into line with what has become standard practice amongst a perceived majority of General Aviation (GA) pilots[29] and with offshore helicopter operators.

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[23] The Irish Meteorological Service.

[24] An example of which was the SCAR Review meeting 14 September 2012 at CAA House.

[25] Data from the Met Office's North Atlantic & Europe limited area forecast model were extracted from the archive for the 5-year study period from October 2006 to September 2011 inclusive and analysed to assess intra and inter proposed ASR pressure gradients, forecasting accuracy and extreme pressure change events.

[26] 14 of 18 consultees expressed a degree of preference for the use of 'actual' QNH values in the Scottish and London FIRs.

[27] Validation criteria are yet to be confirmed by the UK Meteorological Authority.

[28] AIP ENR 1.7 3.9.

[29] Ongoing engagement through the CAA's GA Partnership and specifically at the TA Class G Airspace user Workshop on 31 March 2015 has provided strong supporting evidence for the removal of the RPS system and its replacement with a system based upon the use of actual QNH values.

5.23 Specific principles for ASR design were established by the joint Project that would:

a. provide guidance on the selection of the NASAS;

b. provide commonality of the boundaries between existing airspace structures and the proposed ASRs; and,

c. inform the setting of the dimensions of an ASR and thus the acceptable levels of intra-ASR atmospheric pressure variance.

These design principles, including criteria to guide the selection of NASAS, were incorporated within the UK State CONOP document[30] and are being consolidated within a paper on ASR design criteria that will be published as part of the 2nd State Consultation package. Moreover, for those ASR in UK airspace where ATS is delegated to Ireland, these principles have been applied where appropriate[31] to ensure commonality in design across the FAB. However, key amongst these principles was the determination that the intra-ASR pressure variance should be ≤ 15 hPa for at least 98% of the time, based upon historical meteorological data. Data from the UK Met Office demonstrated that, for up to 98% of the time, there is very little pressure difference across the UK. However, on a small number of occasions, usually during intense storms, the pressure gradient across the UK can be much greater and has, on occasions, been in excess of 30 hPa. Figures 6 and 7 overleaf represent the changeable nature of atmospheric pressure variance within the UK.

[30] First detailed inclusion of design principles in CONOP V 4.3.

[31] The MUNSTA ASR is not 'fully in compliance with these principles'; however, the IAA have determined the boundaries to be appropriate 'based on expected traffic below 18 000 ft in [this] ASR and the proximity of such traffic to the source of the ASR QNH data' (IAA CTA CONOPS V1.1 dated 6 July 15). Through engagement with the IAA, the UK State Project is content that any effects on UK operations caused by the dimensions of the MUNSTA ASR will be manageable.

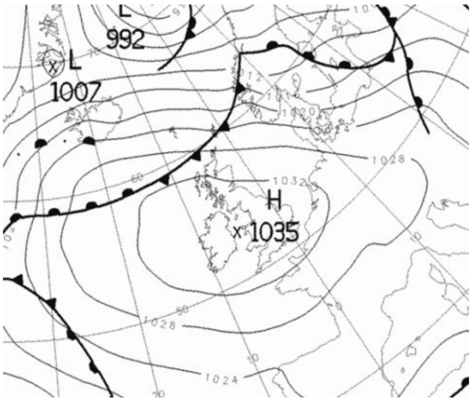

Figure 6: 27th March 2012 High pressure situation. High 1035 hPa over UK. 4 hPa difference covers UK.

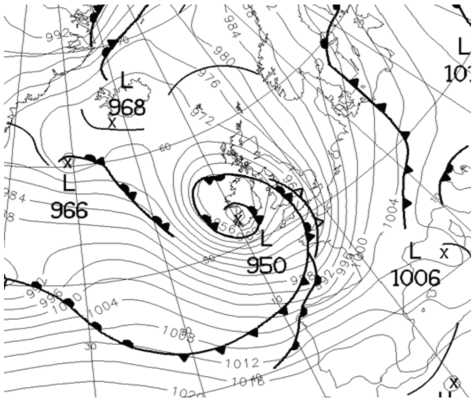

Figure 7: 10th March 2008 Low pressure situation. Low 950 hPa over Republic of Ireland. 980 hPa isobar over E Kent. 30 hPa difference across UK

The relationship between the changing weather patterns and their effects on a specific ASR can be seen in Figure 8 below relating to the KELVIN ASR. The graph shows that the maximum pressure variation within the KELVIN ASR during the period of observation[32] was 17.2 hPa. However it can be seen that these larger variations occur infrequently and would result in surface wind conditions which would preclude a large amount of flying activity; certainly at lower altitudes where the effects of such variance could affect the risk of CFIT.

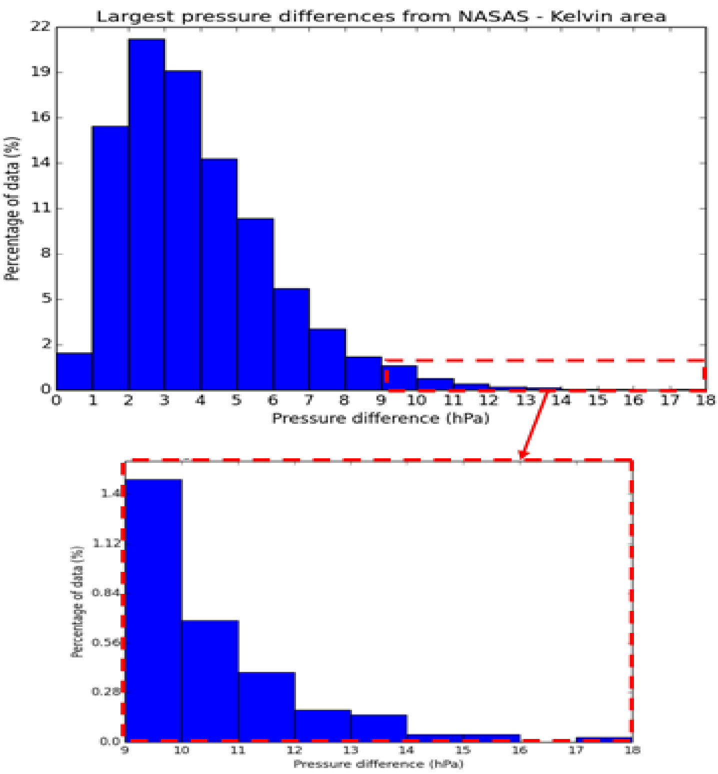

Figure 8: Incidence of Atmospheric Pressure Variance within KELVIN ASR.

[32] Data from the Met Office's North Atlantic & Europe limited area forecast model were extracted from the archive for the 5-year study period from October 2006 to September 2011 inclusive.

5.24 The area of the graph highlighted by the red dotted line and focussed upon in the lower graph within Figure 8, represents the 98th percentile of these pressure differences which was 9.65 hPa. Based upon the observed data, intra-ASR pressure variance within the KELVIN ASR was ≤ 15 hPa on 99.92% of recorded occasions. This compares to the intra-ASR pressure variance observed elsewhere within the UK of ≤ 15 hPa within all ASRs on 99.79% of recorded occasions[33] and 99.90% of recorded occasions within those ASRs which incorporate land.

5.25 Defining the boundaries of the ASR system around these 'worst case' weather events would not have been pragmatic and would result in multiple small ASRs and thus a significant increase in altimeter setting changes and RTF load. Consequently, the use of what's referred to as the 98th percentile of data as a basis for the design of the ASRs represents a balance between gradients within and between ASRs. Moreover, it was a key determining factor in the development of a solution to utilise an ASR QNH to facilitate terrain and obstacle clearance and overflight of airspace reservations[34] in the en-route phase of flight.

5.26 Finally, given that the ASR QNH would be derived from an aerodrome METAR but would not be updated by a SPECI, a difference may arise between the ASR QNH value and the NASAS aerodrome QNH value. Given the potential for this difference to exist, the Project considered that naming the ASR QNH after the NASAS could cause confusion for pilots and ATCOs; consequently, the Project developed a set of principles to provide guidance on ASR naming[35]. These principles were adapted from pre-existing ICAO and CAA documents relating to the establishment and identification of significant points[36]. Taken together, these satisfy **G1.2.2.1**, demonstrating that the ASR design was based on principles agreed by both the UK State Project partners and the IAA.

5.27 <u>ASR Design is Known (G1.2.2.2).</u> (Version 11 of the ASR map is at Annexe B) These ASR design principles were then applied to and tested against data provided by the UK Met Office[37] and the controlled airspace route structure in order to select the NASAS and determine the geographic boundaries and names of the respective ASRs. Initially, in December 2012, the revised ASR structure was planned to only apply to operations within CAS; however, the decision to harmonise the TA across the UK resulted in a requirement to expand the ASR structure throughout UK airspace which resulted in the first edition of the ASR design in May 2013. The design evolved considerably through 2013 and 2014 in light of experience gained through further workshops, ATM development simulations held by the joint project partners and through engagement with other stakeholders[38]; significant changes were:

a. The provision of one ASR QNH to define the area around MOD Boscombe Down, Middle Wallop Airfield, Royal Naval Air Station Yeovilton, the Salisbury Plain Training Area and the Danger Areas in and to the south of Lyme Bay, in order to simplify Class G ATS provision amongst the ANSPs operating in that area.

b. The provision of an enlarged KELVIN ASR, derived from the use of Glasgow as a NASAS, to mitigate operational complexities in the vicinity of Belfast.

c. The amendment of the boundaries between the AVON, LENSTA and MUNSTA ASRs in order to simplify ATM procedures for UK/Ireland air traffic routeing along airway L9.

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33 UK Meteorological Office Variance of Pressure within individual ASRs Version 2 dated 15 April 2015.
34 These procedures will be further discussed in paragraph 5.42d relating to the proposed State Airspace, Flight Crew and ATC Procedures.
35 ASR Naming Convention Policy – Final dated 30 January 2014.
36 ICAO Annexe 11 Chapter 2 Appendix 2 and AIC (Yellow) 97/2008 UK Policy for the assignment and use of ICAO location indicators, 3-letter designators and telephony designators.
37 Data from the Met Office's North Atlantic & Europe limited area forecast model were extracted from the archive for the 5-year study period from October 2006 to September 2011 inclusive and analysed to assess intra and inter proposed ASR pressure gradients, forecasting accuracy and extreme pressure change events.
38 The TA Aviation Stakeholder Engagement file held by the CAA Joint Project Lead refers.

d. Amendments to the southern boundary of the LINDI ASR as a result of the amalgamation of two sectors in Prestwick Centre and the identification of a requirement to minimise altimeter setting selections for aircraft operating to and from Durham Tees-Valley airport.

e. The amendment of the ASR boundary in the vicinity of Ben Nevis in order to reduce the risk of Controlled Flight Into Terrain (CFIT) caused by the potential for a significant inter-ASR pressure gradient to exist.

f. Adaptation of the boundaries between the FRASER and GORDON ASRs to better conform to the Class E+TMZ airways structure.

5.28 Specific activities expected to affect the final stages of the ASR design's evolution prior to initiating the 2nd State Consultation were the conduct of ATM development simulations by NATS and the MOD in Q3-2014 to Q2-2015 and the TA Class G Airspace User Workshop held at CAA House, Kingsway on 31 March 2015. Whilst no issues were identified with the ASR design at the Class G Airspace User Workshop, nor in the MOD's terminal TA simulations, analysis of the results from the NATS ATM development simulations highlighted 2 significant requirements:

a. A change to the AVON/LONDON ASR boundary in the vicinity of the Bristol CTR/CTA to facilitate interactions between Bristol airport, Cardiff airport and en-route traffic; and,

b. A proposal to combine the DONALD and FRASER ASRs[39] to facilitate interactions between en-route and aerodrome ATS providers.

At the time of writing, these requirements had been agreed by the TAPT and incorporated within version 11 of the ASR map (Annexe B); however, they provide a good opportunity to highlight the typical process followed by the Project partners to agree to subsequent changes in the ASR design. As previously stated, proposals to amend the ASR design have arisen from ATM development simulations, hazard analysis workshops and, importantly, through stakeholder engagement. The TAPT then analyse the proposal against the ASR design criteria – particularly in terms of inter and intra-ASR atmospheric pressure gradients – make an assessment of the rationale for the proposed change – which is typically operational in nature – and identify any unintended consequences of the change. The TAPT's decision on the proposal ultimately reflects a balance between the magnitude of any inter and intra-ASR atmospheric pressure gradients and the operational requirement for change. Importantly, alterations to the design of individual ASRs have not impinged upon the overarching requirement that, albeit based upon historical data, intra-ASR pressure variance shall not be greater than 15 hPa based on a 98% probability.

5.29 Following the production of the guidance on ASR naming in January 2014, the Project undertook to develop and propose names for the ASRs which, generally, had some form of link with the geographic area that the ASR encompassed. In the North Sea, however, the NASAS are based upon a number of the rig platforms in the area, for example the Cormorant platform, and it was proposed and agreed that the ASR names could be derived from the platform name. Whilst it was acknowledged that this would not comply with the ASR naming convention guidance, it was felt that the pre-existing platform names were currently used exclusively for North Sea platform helicopter operations and these will not be changed by the extension of the name to cover the whole ASR. Furthermore, the ASR names will be new to other aircraft operators in the area who do not operate from the rigs, thus mitigating the risk of confusion. The risk was further mitigated by the proposal for the North Sea ASR names to tend not to duplicate the name of an existing rig platform; hence Cormorant became CORMO.

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[39] The FRASER ASR detailed within version 10 of the ASR map had previously been 2 separate ASRs; the DONALD and the FRASER. The ASR name DONALD was then applied to an alternative ASR which had not, at that point, been named.

5.30 The final elements of the evolution of the ASR design that require consideration are the ATS infrastructure and processes required to deliver ASR QNH values. As stated, one element of the ASR design principles was a series of criteria for the selection of a NASAS, which included the ability, where possible, to supply METARs on an H24 basis; however, these infrastructure considerations also encompass the:

a. format and transmission methodology of the information both received and communicated by the Civil Aviation Communications Centre (CACC) i.e. NASAS METARS from the weather/aerodrome sensors, the UK Met Office 'Predicted Actual' data and the ASR QNH 'message' or Bulletin;

b. requirements to assure the reliability and validity of the ASR Bulletin up to the point of delivery from the CACC and any assurance processes that may be required at the point of use; and,

c. requirements to assure the reliability and validity of the infrastructure required to deliver and receive the ASR Bulletin.

Whilst the CONOP document details the high level process requirements, these detailed elements will be incorporated within a stakeholder level agreement (SLA) drafted by the UK Meteorological Authority. However, at the time of writing, whilst the key principles and concepts that will be contained within the SLA had been agreed by the Project partners, the SLA itself had not been completed.

5.31 Given that it is anticipated that the ASR design is likely to enter a further period of refinement informed by the results of the 2nd Consultation, it is not yet possible to argue that **G1.2.2.2.1** has been satisfied. However, given that process exists to formalise the evolution of the ASR design and that evidence exists to substantiate this evolution, it is reasonable to argue that the ASR design is sufficiently mature, subject to the completion of the SLA being drafted by the UK Meteorological Authority and its acceptance by the TAPT.

5.32 Similarly, given the anticipated requirement to refine the ASR design in the light of consultation responses, it is not yet possible to argue that the final ASR design is complete and that **G1.2.2.2.2** has been satisfied. Moreover, in terms of the current phase of the Project, the baselining of the ASR design that will be proposed in the 2nd State Consultation will be achieved through the publication of the State CONOP V5.2 and the associated ASR design V11. Subject to the delivery of State CONOP V5.2 and ASR design V11 in August 2015 and their acceptance by the TASG, there will be sufficient evidence that the ASR design has been baselined for this stage of the project.

5.33 <u>ASR Design has Been Validated (G1.2.2.3).</u> As per the validation of the TA chosen (**G1.2.1.2**), the process of validating the ASR design will only be completed following the conclusion of the 2nd State Consultation process. Pre-consultation evidence that the State will use to validate the ASR design includes elements of individual analyses by NATS and MOD and that produced through engagement with stakeholders, other than the joint project partners, that are affected by the raised TA; for example, non-NATS ANSPs. Whilst this engagement was sought without prejudice to the subject organisation's ability to comment on the 2nd State Public Consultation, it served to de-risk the consultation by allowing the project to mature collaboratively.

5.34 Stakeholders at the TA Class G Airspace user workshop did not raise any concerns with the ASR design principles and NASAS selection criteria, nor with the ASR design itself. Critically, they also endorsed the Project's use of the 98th percentile of meteorological data as a basis for the ASR design. However, whilst not concerned with the specific ASR names proposed, GA stakeholders highlighted that the rationale for the selection of certain ASR names was not clear and it was agreed that this would be included within the consultation documentation. More importantly, some stakeholders observed that the inter-ASR atmospheric pressure gradient – a function of the use of ‘actual’ QNH values and distance between the respective NASAS – could pose challenges in coordinating flights at ASR boundaries. This observation was echoed in analyses conducted by the Project partners and, given that this relates to how the ASRs will be utilised rather than the design itself, it is considered in the section of this SSAR relating to the proposed State airspace, flight crew and ATC procedures (paragraph 5.40 onwards).

5.35 Other than those issues highlighted above (paragraph 5.34) the analyses from the Project partners did not highlight any further concerns with the ASR design and it is reasonable to argue that this in itself may be interpreted as a form of validation of that design. However, this was to be expected due to the way that the Project and external stakeholders collaborated on the ASR design, ensuring that the solution delivered met the requirements of all parties. Given the collaborative nature of this decision making, agreement on the specific delivered solutions could be interpreted as a form of validation. Examples of this were the resolution of issues regarding the North Sea ASR names and the challenges for ANSPs operating in the vicinity of Belfast at the extremities of the KELVIN ASR.

a. Given that the proposed names for the North Sea ASRs were derived from platforms and thus did not comply with the guidance on ASR naming, the project took the opportunity to validate their selection through engagement with representatives of the North Sea helicopter operators and ATS providers at a meeting in Aberdeen[40]; no concerns were raised.

b. During the evolution of the ASR design, the selection of the NASAS for the KELVIN ASR and determining whether a separate ASR based upon Belfast should be established prompted considerable debate. In short, the discussions centred upon managing the interfaces between Belfast International Airport, the IAA (ANSP) and Prestwick Centre and mitigating the effects of the intra-ASR atmospheric pressure variance that occurs as a result of the distance between Glasgow and Belfast, Dublin and Donegal. An enlarged KELVIN ASR (paragraph 5.27b refers) was agreed[41] in principle by representatives of the IAA, UK State Project, Prestwick Centre and NATS Belfast (aerodrome ATS provider) as a viable and pragmatic operational solution, with specific interface arrangements to be detailed during the implementation phase of the Project.

5.36 Finally, given that the safety of the ASR design is, in part, reliant upon the ability of the UK Met Office to accurately predict ASR QNH values, an assessment of this accuracy is required. Based upon 2 locations which the Meteorological Authority considered to be sufficiently representative of atmospheric conditions throughout the UK, forecasts for 1, 2 and 3 hours ahead were evaluated by the Met Office and deemed by the Authority to be “extremely accurate…at this time range”[42]. 18 491 forecasts were reviewed at Charlwood (near Gatwick) and 17 945 were reviewed at Bishopton (near Glasgow) and the results from this analysis are in Table 1 overleaf.

[40] Aberdeen TA Interface Meeting, 19 November 2014.
[41] Belfast TA Interface meeting 6 August 2014.
[42] Email from UK Meteorological Authority to State TA Project Safety Manager on 20 May 2014.

Charlwood	
Time	**% of occasions where forecast QNH is < ± 1 hPa of actual QNH**
T+1	99.95
T+2	99.88
T+3	99.69
Bishopton	
T+1	99.96
T+2	99.83
T+3	99.60

Table 1: Accuracy of Pressure Forecasting within the UK.

5.37 At this stage in the Project, evidence that the ASR Design has Been Validated (**G1.2.2.3**) is limited to the confirmation that the ASR design conforms to the design criteria developed by SQEP within the project and that no concerns have been raised directly in relation to the final ASR design itself, that have not been addressed. It is reasonable to argue that this validation evidence is sufficiently mature at this stage of the Project's lifecycle in order to progress. However, consideration will be required as to what additional activity/evidences may be required to validate the final ASR design in the light of any evolution that occurs following the 2nd State consultation.

5.38 **Summary – The Specific TA Chosen and ASR Design are Acceptably Safe.** The UK has determined that it shall pursue the implementation of a harmonised, raised TA of 18 000ft. Direct validation of the TA of 18 000ft will not be possible and thus it will be inferred through the validation of the associated ASR design and Airspace, ATC and flight crew procedures. Understandably, given the phase of the project, this validation has yet to be completed; however, activity is underway for this to be delivered within the anticipated timeline following the 2nd State Consultation, to permit certainty as the project enters the implementation stage of activity. In terms of progress towards satisfying **G1.2.2**, we can state that **G1.2.2.1** has been satisfied. Subject to the completion of works identified within paragraphs 5.31 and 5.32, whilst **G1.2.2.2** and **G1.2.2.3** are not yet satisfied, it is reasonable to argue that sufficient maturity will exist within the ASR design to permit the Project to progress.

The Proposed State Airspace, Flight Crew and ATC Procedures are Acceptably Safe (S1.3)

5.39 Through **S1.3**, a series of further sub-goals were identified to demonstrate that the Proposed State Airspace, Flight Crew and ATC Procedures are acceptably safe; this is depicted in Figure 9. The goal is made in the context that such State procedures will be defined and promulgated within the UK AIP and associated CAPs.

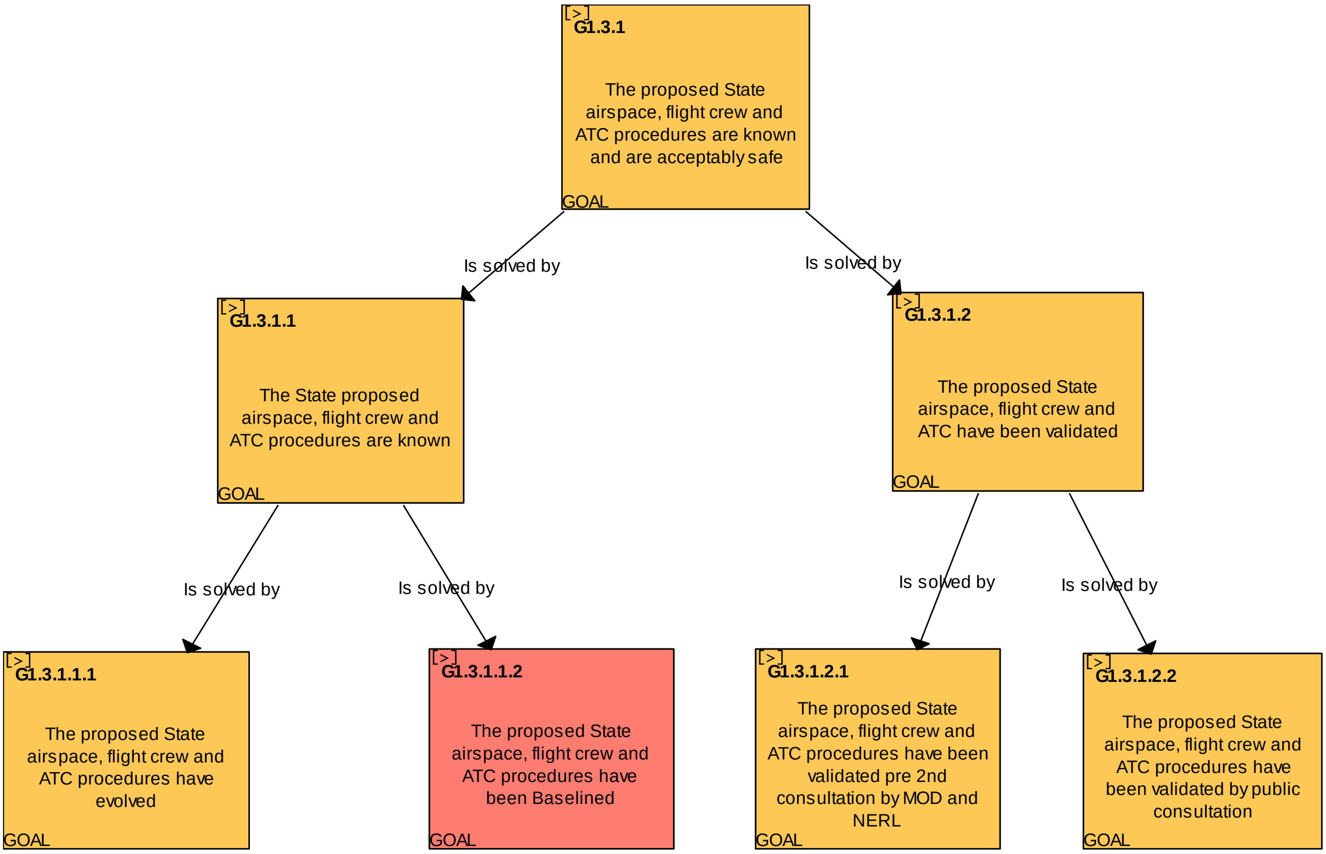

Figure 9: The Proposed State Airspace, Flight Crew and ATC Procedures are Acceptably Safe (S1.3)

5.40 <u>The Proposed State Airspace, Flight Crew and ATC Procedures are Known (G1.3.1.1).</u> The evolution of the airspace, flight crew and ATC procedures associated with the State TA project has been driven by the need to mitigate identified safety risks and informed by development activity of the TAPT. This activity culminates in the State CONOP document which is the repository for the State procedures associated with the TA change, prior to their later incorporation into the UK AIP and CAPs.

5.41 The UK State Joint CONOP document was first produced in May 2013 as Version 1, continues to be revised through an iterative process and is closely mirrored by the CONOP proposed by the IAA. Following the initial development and publication of Version 1, the CONOP text has been revised by specific individuals representing the 3 joint partners, prior to peer review by the TAPT. CONOP editions with significant amendments to the technical content have also been peer reviewed by the TASC; specifically iterations of Version 3 (which included the first detailed text on the concept of a QNH tolerance) and Version 4 (the introduction of procedures relating to the use of an ASR QNH to support terrain safe flight and safe under/overflight of airspace reservations and a significant addition to the text on QNH tolerance). At the time of writing, CONOP V 5.2 was in the process of being finalised and it is this version of the CONOP on which the 2nd State Consultation will be based and will be subject to peer review by both the TAPT and TASC. As the TA project moves towards that Consultation, responsibility for the development of the CONOP document will transition from the joint project partners to the CAA in Q3 2015.

5.42 As stated, CONOP development and the supporting activity undertaken by the joint project partners has been aimed at mitigating the safety risks identified in Section 8. Specific areas of activity have been:

a. **Confirming the Relationship between the Divisional Flight Level (DFL) and the TA.** During CONOP development it was determined that there were differing views amongst the joint project staff on the 'primacy' of the DFL[43] over the proposed TA, on those occasions where very low pressure might cause them to be in relatively close vertical proximity. This was considered to be a particular issue in scenarios where Class G airspace lies directly below Class C airspace, resulting in Class G airspace users requiring unambiguous guidance in order to avoid an infringement of Class C airspace. Following a meeting held at CAA House[44] between representatives of CAA SARG Airspace Regulation (AR) and CAA Legal, it was confirmed by CAA SARG's Manager Airspace[45] that the DFL was inviolate and that the airspace above the DFL is "always Class C, irrespective of the Class of airspace below and the effects of very low pressure"; the responsibility of ensuring that Class C airspace was not infringed rested with the pilot of the flight within Class G airspace. This decision thus informed other aspects of project development, specifically the work related to the safe under flight of airspace reservations.

b. **Confirming the Relationship between Temporary Reserved Areas (TRA) and Class E Airways.** Having confirmed the relationship between the DFL and the proposed TA, the Project Team determined that a similar issue existed where a Class E airway vertically abuts an active TRA. In this instance, as the lower limit of the TRA mirrors the DFL, it was considered by the Project that the onus remained upon the pilot and/or ANSP operating in Class E airspace to ensure appropriate separation from the TRA.

c. **Confirming the effects of a raised TA on Airspace data.** A decision was taken early in the life of the Project to amend the published bases of airspace and routes where they are currently defined as Flight Levels at or below FL180 such that, where bases are currently defined at FL175 and below, they will change to altitudes of 17 500ft and below. However, the second-order effect of the introduction of ASRs was to introduce a safety risk of airspace infringement caused by confusion in the minds of pilots and ATS personnel on the correct altimeter setting data for Airways, CTA, TMA and other airspace reservations[46]. In order to mitigate the risk of infringement, the Project determined that:

(i) A Control Zone (CTR) should continue to be defined from the Surface to a defined altitude above mean sea level (AMSL) based upon the Aerodrome QNH.

(ii) The base altitude of those CTAs associated with aerodrome CTRs should continue to be defined by the associated aerodrome's QNH.

(iii) The base altitude of those CTAs not associated with an aerodrome CTR should be defined by the ASR QNH of the ASR in which it lies.

(iv) The base altitude of an airway should be defined by the ASR QNH of the ASR in which it lies.

(v) The base altitude of a TMA should be defined by the ASR QNH of the ASR in which it lies.

[43] The DFL (currently FL195) is the level above which EU regulations require that Class C airspace must be established.
[44] Meeting to discuss the Proposed 18 000ft TA v DFL195 issue at CAA House K5 Wright Room, 22 January 2014
[45] Email from CAA SARG Airspace Regulation to Joint Chair of TAPT on 18 March 2014.
[46] Danger Areas, Restricted Areas and Prohibited Areas.

(vi) The top limit of airspace reservations that exist from the surface to a specified upper limit, such as Danger Areas, Restricted Areas and Prohibited Areas would continue to be defined as an altitude. However, it was acknowledged that this posed challenges in determining an appropriate level for overflight where the atmospheric pressure in the vicinity of the reservation was not known.

(vii) The base of 'floating' airspace reservations, such as the Managed Danger Areas over the North Sea and Irish Sea, should be defined by the ASR QNH of the ASR in which they lie. Where such a reservation spans a number of ASRs, it is acknowledged that the base will vary according to the defining atmospheric pressure.

Allied with this, the Project determined that these airspace data would then be represented on the 'quarter million' and 'half million' charts; albeit that the means of doing this has yet to be agreed. With the certainty that CAS data beneath 18 000 ft will be defined on either an aerodrome QNH or an ASR QNH, it is reasonable to argue that the task of avoiding airspace infringement for ATS personnel and flight crews will be simplified, considering the nuances of the current system described in Section 3.

d. **Terrain Clearance and Safe Over/Under Flight of Airspace Reservations[47].** The definition of CAS base levels beneath the TA utilising either an aerodrome QNH or an ASR QNH means that the task of avoiding infringement of CAS has been simplified for pilots and ATS providers alike. However, the proposed removal of the RPS system meant that a new solution was required to enable both en-route and aerodrome ATC providers to determine minimum safe levels for terrain and obstacle clearance and for overflight of airspace reservations. At this point, the design of airspace reservations within the UK bears consideration.

Generally, where an airspace reservation exists from the surface, it is based upon a requirement for a specific volume of air above ground level (AGL) that is then converted to an 'above mean sea level' (amsl) value. However, typically, there is no means of providing an altimeter setting datum specifically for these reservations and thus, today, the RPS may be used as a mechanism to effect overflight.

Whilst the rationale for the use of 'actual' QNH values in defining ASRs has been articulated (paragraphs 5.21 and 5.22), the use of an 'actual' QNH value in place of the RPS introduces a risk regarding terrain safe flight and the safe over-flight of airspace reservations due to the effects of atmospheric pressure variance. There are a number of factors which affect this but key amongst these is distance. Specifically, the distance between the point where the pressure is measured, to the feature that you are overflying; thus, the further you are from the point where the pressure is measured, the greater the likelihood of a difference or 'gradient' between the 2 pressures. This is related to the aviation adage that when moving from high pressure areas to low pressure areas, pilots should 'look out below'; Figure 10 overleaf depicts this issue.

[47] Airspace reservations is a generic term used to encompass CAS, ATZs, Danger Areas, Restricted Areas and Prohibited Areas.

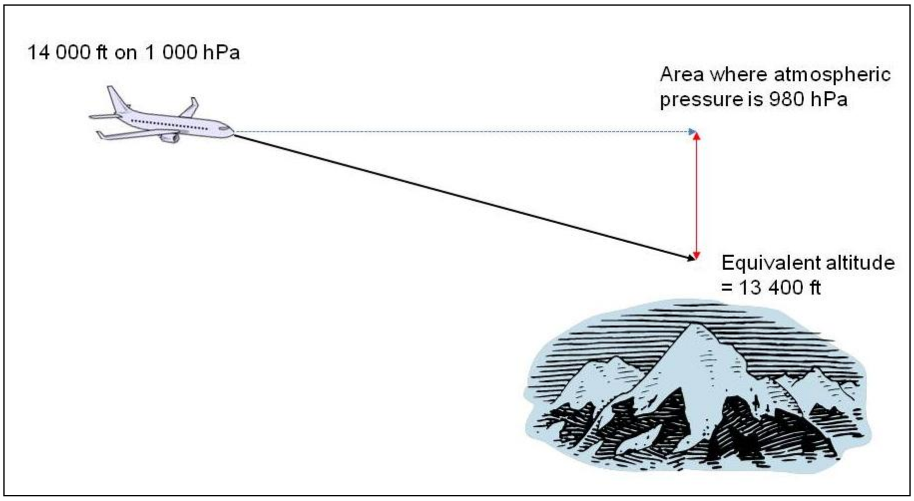

Figure 10. From 'high' to 'low', lookout below.

Consequently, the challenge posed to the Project by the effect of atmospheric pressure variance was to determine a means to:

(i) use an ASR QNH in a manner that provided both terrain and obstacle clearance and overflight of airspace reservations; and to

(ii) use an aerodrome QNH in a manner that enabled overflight of airspace reservations[48].

The solution proposed by the Project team was to require flight crews and ATC providers to add a correction to any terrain, vertical obstruction or the depicted top altitude of an airspace reservation, where the upper vertical limit is defined as amsl. The magnitude of this correction is dictated by the range from the source aerodrome where an aerodrome pressure setting was utilised, or, known variance within an ASR where an ASR QNH value was utilised[49]. The corrections proposed are as detailed in Table 2 below:

ASR QNH		
Correction (ft)	**Equates to (hPa)**	**When applied**
200	7.3	All the time
500	18.3	On receipt of a Met pressure warning
Aerodrome QNH		
Correction (ft)	**Equates to (hPa)**	**When applied**
Nil	-	Overhead the source aerodrome to 25nm
100	3.7	Between 25nm and 40 nm from the source aerodrome

Table 2. Corrections to be Applied to Level Allocations when using ASR and Aerodrome QNH.

[48] Existing practises by aerodrome ATC providers utilising a combination of an aerodrome QNH and an ATC Surveillance Minimum Altitude Chart (ATCSMAC)[48] to afford terrain and obstacle clearance will remain unchanged and thus there is no safety effect to address.
[49] When a large pressure gradient is forecast (≥6 hPa[49]) across an ASR, the ASR QNH bulletin will contain a warning to alert users. This warning will prompt users to 'add' an additional 300 ft to any terrain, vertical obstruction or the depicted top altitude of an airspace reservation, where the upper vertical limit is defined as amsl.

Thus it follows that where atmospheric pressure variance exceeds 3.7 hPa using an aerodrome QNH, or 18.3 hPa using an ASR QNH, **and** that it is a 'lower' value than the altimeter setting datum utilised, the vertical correction is insufficient to address the pressure gradient. Consequently, we must assess the likelihood of this to occur, alongside a consideration of the potential safety effects, in order to determine its acceptability.

Considering first the use of an ASR QNH, Met Office data[50] indicates that such conditions had been witnessed only within the 6 most northerly of the proposed ASRs[51] and on less than between 0.02 % and 0.11 % of occasions within the data set, dependent upon the ASR[52]. Based upon the maximum pressure difference observed within the data set[53], this would result in an aircraft being up to 187 ft[54] lower in relation to its vertical position above ground level (AGL). However, whilst a variance of > 18.3 hPa within an ASR would negate the effect of the 500 ft correction applied by flight crews and ANSPs, it would not wholly negate the minimum obstacle clearance (MOC)[55] applied by flight crews operating IFR and ANSPs in determining safe cruising levels; thus MOC would reduce to no less than 813 ft. Given the limited probability of the event and that the risk of CFIT is not increased due to the balance of the remaining MOC allowance, the CAA believes that this is acceptable. Putting the Met Office data into the context of enabling overflight of airspace reservations, in those two ASRs[56] where airspace reservations currently exist with an upper limit defined as amsl, extremes of variance could result in a 'technical' airspace infringement of up to 13 ft in the GORDON ASR and 3 ft in the FRASER ASR[57].

We should also consider the effects of pressure variance on the use of an aerodrome QNH. Met Office data from a representative sample of aerodromes[58] from across the UK, indicates that:

(i) Within 25 nm of the source aerodrome, pressure variance was > 2 hPa on 0.7 % of occasions and > 3 hPa on 0.03 % of occasions.

(ii) Within 40 nm of the source aerodrome, pressure variance was > 3 hPa on 2.7 % of occasions and > 4 hPa on 0.6 % of occasions.

(iii) The maximum pressure difference observed within 25 nm of an aerodrome was 3.2 hPa (equates to 87 ft) and 6.1 hPa (equates to 167 ft) within 40 nm.

(iv) The 98th percentile maximum pressure difference observed within 25 nm of an aerodrome was 1.8 hPa (equates to 49 ft) and 3.2 hPa (equates to 87 ft) within 40 nm.

Consequently, based upon the maximum pressure difference observed within the data set, this could result in an aircraft being up to 167 ft lower in relation to its vertical

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[50] UK Met Office Variance of Pressure within individual ASRs Version 2 dated 15 April 2015. Elements of this data are duplicated at Annexe D for reference, with thanks to the UK Met Office.
[51] GORDON, ODIN, DONALD, FRASER, KILDA and CORMO.
[52] Only data on the maximum pressure difference between the NASAS and all points within the ASR, and the incidence of pressure differences greater than 15 hPa is available. As an example, CORMO ASR experienced the greatest incidence of pressure variance > 15 hPa at 0.21% and the maximum observed pressure difference was 20.97 hPa. It is not possible to determine the exact incidence of pressure difference greater than 18.3 hPa, nor is it possible to determine the 'direction' of those differences in relation to the pressure source. We can argue however that there is an approximate 50:50 split between those occasions when atmospheric pressure variance within a defined area is lower than the pressure datum for that area. Thus, there was a 0.105 % occurrence of variance >15 hPa **AND** of a lower value than the ASR QNH.
[53] KILDA ASR, maximum observed pressure 25.16 hPa.
[54] KILDA ASR 25.16 hPa = 686.87 ft. Minus 500 ft correction = 186.87 ft lower in relation to AGL.
[55] MOC determined to be 1 000 ft as UK does not promulgate mountainous terrain.
[56] GORDON and FRASER.
[57] Whilst the upper limit of EGD 809 within the ODIN ASR is 55 000 ft amsl, as it is above the proposed TA, alternative means to enable overflight will be required which are likely to wholly negate a risk of infringement.
[58] It is not possible to determine the exact incidence of pressure difference greater than 3.7 hPa.

position above ground level (AGL). However, as indicated above, this would be dependent upon the distance of the aircraft from the aerodrome. Thus, based upon the procedures proposed by the Project and detailed in Table 2, if an aircraft was operating at the lowest level available above the reservation – i.e. 1 ft above the upper limit – this could result in a 'technical' airspace infringement of up to 87 ft within 25 nm of the aerodrome or 67 ft between 25 and 40 nm of the aerodrome. However, it is considered unlikely that a pilot would elect to operate at the lowest level available and is likely to select the next useable 'whole hundred foot' interval. Moreover, it is standard ATC practise to assign levels at whole hundreds of feet.

It is first worth highlighting that these marginal airspace infringements will be involuntary and not apparent to the pilot, in that they will not be aware of the local pressure variance causing the reduction in the aircraft's level AGL. To all intents and purposes, when flying in accordance with the published procedure with an appropriate altimeter setting, they will be flying at a level which is considered to be above an airspace reservation. Moreover, given the known allowances for altitude keeping requirements of pilots[59] and aircraft[60], it can be seen that the potential magnitude of infringement is contained within these. However, irrespective of whether an ASR QNH or an aerodrome QNH is used, what are the safety effects of operating with such a reduction in altitude?

- With regards to Prohibited Areas and certain Restricted Areas, the purpose of the established volume of air is to permit aircraft to 'glide clear' of the area following an engine failure; it is considered highly unlikely that a reduction in height AGL of up to 87 ft would prejudice a pilot's ability to do this. Consequently, there is no safety effect.

- Other Restricted Areas are established to prevent the deliberate overflight of sensitive facilities. Consequently, there is no safety effect to the overflying aircraft of such a marginal infringement.

- EG R610 (The Highlands)[61] and EG R313 (Scampton) are an exception in that they are established to contain aerial activity. As such, the safety effect of any marginal infringement is similar to that for air weapons ranges. Whilst acknowledging that aircraft operating within these areas may not be able to fully comply with the Rules of the Air[62], pilots operating in the vicinity of Danger Areas 'are strongly advised to make use of a Radar Service'[63]. Moreover, those pilots are also required to comply with the Rules of the Air and the effect of such a technical and unlikely to be detected infringement is considered highly unlikely to place the aircraft into direct conflict. As such, it is reasonable to argue that the safety risk associated with such a marginal infringement is similar in nature to that which exists in Class G airspace today and that the extant mitigations will continue to apply.

- The design of a Danger Area where weapons systems are fired from the surface incorporates a 1 000 ft vertical 'buffer' above the 'Weapon Danger Area'[64] before conversion to a level amsl and the associated rounding up to the nearest whole hundred feet. Consequently, there is no safety effect to the overflying aircraft of such a marginal infringement.

[59] Appendix 7 to EU No 1178/2011 and CAA Standards Document 19(A) Notes for the Guidance of Applicants taking the PPL Skill Test (Aeroplanes).
[60] Air Navigation (General) Regulations 2006 Part 6 Paragraph 16.
[61] When activated by NOTAM.
[62] SERA.3201 General, SERA.3205 Proximity and SERA.3210 Right-of-Way.
[63] UK AIP ENR 1.1 5.1.3.1.
[64] The 'Weapon Danger Area' refers to the volume of air AGL which is designed to contain all normal weapon effects; the vertical 'buffer' of 1 000 ft is then added to this.

Having considered the safety risk, it is useful to also consider the degree of exposure to that risk. Elements of this have been discussed already in detailing the low likelihood of the effects of pressure variance on an aircraft's level when utilising an ASR QNH and an Aerodrome QNH. However, there is a direct correlation between pressure variance and weather events, specifically the surface wind. Table 3 overleaf details the geostrophic wind (≈ 3 000 ft) and approximate surface wind[65] for varying degrees of pressure variance over a distance of 50 nm and with increasing latitude. Note that with increasing latitude, the wind decreases in speed for the same pressure gradient.

Pressure Difference (hPa)	60 N		55 N		50 N	
	Geostrophic Wind	Surface wind	Geostrophic Wind	Surface wind	Geostrophic Wind	Surface wind
3	41.4	20.7	43.2	21.6	46.8	23.4
4	55.2	27.6	57.6	28.8	62.4	31.2
5	69.0	34.5	72.0	36.0	93.6	39.0
6	82.8	41.4	86.4	43.2	93.6	46.8

Table 3. Wind as a Product of Increasing Pressure and Latitude.

It is reasonable to argue that the magnitude of surface winds which would result from pressure differences ≥ 4 hPa would begin to preclude aviation activity generally, and activity within Danger Areas and Restricted Areas; a view that has been supported by attendees at a Class G Airspace user workshop and specialists within CAA SARG.

It is likely, yet unprovable, that we have been exposed to the risk of involuntary marginal airspace infringement of the magnitudes described above for decades, due to a lack of understanding of the effects of atmospheric pressure variance. This proposal by the State Project provides clarity on these issues and provides pragmatic solutions in a manner which the State considers to be acceptable[66] and reduces the risk of infringement to a level that is ALARP. That said, a number of aspects related to this proposal require further work by the State Project and/ or the CAA; specifically:

(i) Where the upper limit of airspace reservations exists above the TA but is defined as amsl, a procedure needs to be determined to derive a minimum crossing Flight Level.

(ii) A State-level routine monitoring process will be required to provide safety assurance that levels of atmospheric pressure variance remain broadly consistent with the data used to underpin this argument.

(iii) Due to extremes of pressure variance observed in maritime areas, a means to consider the effects of atmospheric pressure variance in establishing new temporary or permanent off-shore airspace reservations will need to be derived.

e. **MOD Lowest Forecast Pressure.** In parallel with the work referred to above, the MOD established through its own safety analyses that they had an enduring requirement for the provision of a lowest forecast pressure (LFP) to their aircrews to facilitate terrain separation whilst engaged in low-level flying. This is in order to mitigate the risk of CFIT in the event of a climb-out from low level in restricted visibility and work is ongoing by the MOD to develop the concept and associated procedures. However, from a State safety assurance perspective, it will be sufficient to determine that the MOD's use of a lowest forecast QNH has no safety implications for civilian

[65] The surface wind is approximately 50 to 60% of the value of the geostrophic wind.
[66] Meeting to discuss the legal position of the TA project relating to the overflight of Airspace Restrictions at CAA House K6 Mitchell Room, 3 August 2015.

Class G airspace users or ATS providers and that measures have been taken by the MOD to ensure that the concept does not 'leak' into the civilian ATM system. The LFP will be distributed by the Met Office on the MOD MOMIDS system to military users only, will be utilised solely within the cockpit by military pilots whilst engaged in autonomous low flying operations and will not be utilised for ATS provision.

f. **The Nominal Vertical Separation Minima Concept.** Relatively early in the lifecycle of the project, it was realised that a raised TA would pose a challenge to the maintenance of a 1 000ft Vertical Separation Minima (VSM) between multiple interacting airport arrival and departure procedures operating on varying aerodrome QNH values and the further interaction of these with en-route traffic cruising beneath the TA on the ASR QNH. A concept of nominal[67] VSM was proposed with significant work undertaken to understand and address vertical error within the ATM system, aircraft automation, effects on TCAS, flight crew human factors and meteorological data. This activity resulted in a final research paper within the Project which:

(i) consolidated all evidences gained on the concept of nominal VSM.

(ii) detailed the UK State TA Project's safety argument for the concept of a nominal VSM through the application of a QNH tolerance.

(iii) stated a maximum QNH tolerance value that may be applied by ANSPs;

(iv) proposed a number of applications of the nominal VSM principles; and,

(v) detailed the scope of the safety argument for the use of the nominal VSM concept and the generic contents of an ANSP safety case for its application.

This paper reflects a significant body of safety assurance evidence in its own right and is available to view. As such, it would not be appropriate to duplicate this work herein. However, it should be noted that this concept provides processes that mitigate the significant extra RTF phraseology, mental workload, and likely airspace capacity constraints that would have resulted from the blanket application of an absolute 1000ft VSM in all cases.

g. **RTF Phraseology Requirements.** The initial quantitative and qualitative analyses undertaken by NATS to inform the choice of the TA, alongside subsequent hazard analysis workshops, identified that a harmonised, raised TA would – in certain sectors and phases of flight – increase the RTF load for both pilots and ATS personnel; for example through the increased length of transmissions and an increased number of transmissions.[68] These analyses resulted in the establishment of RTF principles that are stated within the CONOP – and have thus been subject to peer review – and which have been supplemented and refined by CAA policy decisions[69] and experience gained through workshop activity. Subsequent work undertaken by the joint Project has seen a number of proposals made to the CAA on means of reducing RTF load. Some have been rejected on the grounds that they would introduce a difference between the UK, ICAO and EASA, some on the grounds that they had a potentially adverse impact upon safety, whilst a number have required further safety analysis by the Project. A number of these proposals are being actively pursued by the CAA, including the abbreviation of the term hectopascal, making the use of the term 'feet' optional in RTF messages

[67] A nominal VSM exists when aircraft are assigned cruising altitudes separated by 1000ft but where the aircraft are operating with a variance or QNH Tolerance of up to 5 hPa between their respective altimeter settings. In this way, less than 1000ft of air exists between the two aircraft and thus the separation is 'nominally' 1000ft, based on the assigned cruising altitude (UK TA CONOPS V5.2).
[68] Use of the terms 'height' and 'altitude' in accordance with UK RTF Policy (CAP 413 Edition 21 Amendment 5 Paragraph 3.9), increased requirement to transmit QNH values (use of aerodrome and ASR QNH, including ASR QNH value changes induced by ASR Bulletin updates and by crossing ASR boundaries).
[69] Recorded within the State TA Regulatory/Policy Decisions Log.

relating to altitudes and heights and the introduction of the word 'ten' in RTF messages relating to the transmission of altitudes and heights. Given the ongoing work by ICAO and by EASA on SERA 'Part C' and 'Part-ATS', the development of these proposals is dependent, to an extent, upon EASA. Therefore, the unilateral development and implementation by the UK of these proposals is, to an extent, constrained and cannot be taken for granted as a means to mitigate RTF load.

h. **Radar Data Processing System.** Initial hazard identification work undertaken by the project in early 2013 identified that, combined with a raised TA, the processing of SSR pressure altitude reports by Radar Data Processing Systems (RDPS) and the pressure datum which was 'programmed' into RDPS posed a safety risk of increased ATCO workload which could contribute to MAC. Specifically, the Project identified that when aircraft are climbing or descending, the display of either altitude or Flight Level on the surveillance display may change as they pass through the Transition Layer. In specific pressure situations where surveillance QNH conversion areas[70] are used, the aircraft's SSR pressure altitude report could appear to 'jump' or 'drop'. Whilst this occurs today, it may be more apparent and may take a longer time period to change due to slower climb rates at higher altitude. Similar events, depending on the datum selected on radar display at civilian and military units and pressure differentials, may occur as aircraft cross ASR and FIR boundaries. Moreover, depending on radar data processing, if there is more than one processing datum for pressure, the user will experience 'jumps' in the displayed SSR pressure altitude at the processing boundary and 'creeps' of the displayed SSR pressure altitude as the aircraft adjusts to capture the altitude. In order to ensure that ATS providers were aware of these issues, the Project undertook to highlight these within the State CONOP[71], which will complement guidance material provided by the Project which identifies the current variations in RDPS pressure datum setting and future options with a raised TA.

i. **ASR Bulletin.** At the time of writing, the procedures and processes regarding the creation, format and promulgation of the ASR Bulletin were being finalised and thus cannot be commented upon herein.

j. **Altimeter Setting Procedures.** Whilst not listed as a difference within UK AIP GEN 1.7, the UK's altimeter setting procedures[72] in relation to changing between an aerodrome QNH and the Standard Pressure Setting (SPS) differ from that stated by ICAO[73]. The UK State TA Project considered that the proposed changes to the TA provided an opportunity for the UK to review this position and requested the CAA to consider this; however, at the time of writing, no progress had been made on conducting this review.

5.43 Whilst this SSAR has identified a requirement for further work in order to satisfy **G1.3.1.1.1**, the State Project has always acknowledged that further evolution may occur in response to comments received from aviation stakeholders during the 2nd State Consultation. However, it is reasonable to argue that the Project has undertaken activity to develop and evolve procedures and processes that address the main areas of safety risk identified by the Project. Indeed, a number of the concepts already have a significant body of safety assurance evidence to underpin them, a topic which will be re-visited later in this section. However, this statement should not be taken as meaning that the procedures have evolved to the point where they are demonstrably acceptably safe; merely that the procedures have evolved to a point where their validation and baselining for entry into a 2nd State Consultation may be considered. The publication of CONOP V5.2 and the associated ASR Map V11 and

[70] A surveillance QNH conversion area is an area defined by an ANSP within the Radar Data Processing System for the purposes of managing the processing of Raw SSR Mode C information transmitted from an aircraft transponder. Within such areas, the SSR Mode C information from flights operating beneath the TA is converted to an altitude above mean sea level using the QNH value applicable to the airspace within which the aircraft is flying.
[71] CONOP V5.2 paragraphs 8.4 to 8.6.
[72] UK AIP ENR 1.7 5.1.4 and 5.3.1.
[73] ICAO Doc 8168 PANS-OPS Volume 1 3.3.3 and 3.5.3.

their subsequent acceptance by the TASG will, for the purposes of the 2nd State Consultation, baseline the proposed State-level, airspace, flight crew and ATC procedures. However, it is worth highlighting that, subject to any evolution of the CONOP and an implementation decision made by the CAA following the consultation, in order to permit an ordered implementation and transition, a formal and final baseline decision will be required by June 2016.

5.44 <u>The Proposed State Airspace, Flight Crew and ATC Procedures have been Validated (G1.3.1.2).</u> As highlighted in the text regarding the validation of the ASR design (**G1.2.2.3**), specifically paragraph 5.33, the State will undertake activity to validate the proposed State airspace, flight crew and ATC procedures prior to the 2nd State Public Consultation (**G1.3.1.2.1**). This will include consideration of the individual analyses by NATS and MOD (incorporating safety assessment and ATM simulation of the concepts), and engagement with stakeholders other than the joint project partners that are affected by the raised TA; for example, non-NATS ANSPs. Whilst this engagement is sought without prejudice to the subject organisation's ability to comment on the 2nd State Public Consultation, it serves to de-risk that consultation by allowing the project to mature collaboratively.

5.45 As stated in paragraph 5.43, a number of the concepts proposed by the Project have already accrued a significant body of safety assurance evidence. For instance, the nominal VSM concept and safety argument has been endorsed by the TASG and is undergoing a process of approval within the CAA. Moreover, the proposed mechanism for the use of an ASR QNH in terrain safe flight and safe over-flight of airspace reservations was tested by a representative group of Class G airspace users[74] and determined to be acceptable in principle. Critically, they endorsed the Project's view that periods of significant intra-ASR pressure variances would preclude flying operations at lower altitudes where terrain clearance calculations may be affected. It is acknowledged by the State Project that the proposal appears to add complexity to the task of both the pilot and controller by requiring them to add a correction that had previously been included within the RPS and was thus not obvious to the user; however, this perception of complexity was not echoed by workshop attendees. GA representatives at the workshop and the results of the MOD's terminal TA simulations endorsed the Project's view that existing practises by GA pilots and aerodrome ATS providers will remain largely unchanged; the use of an ASR QNH being of use primarily to en-route ATS providers and flight crews of IFR commercial flights. Furthermore, attendees stated that, whilst they had some concerns regarding the nature of the interface at the FIR boundary with adjacent states operating the system of intermediate VFR cruising levels (Appendix 3 to SERA.5005 g), they had no concerns regarding the risk of MAC at the FIR boundary.

5.46 However, evidence from the safety analyses conducted by the Project partners has indicated 2 specific issues where, at the time of writing, the level of indicative safety risk remains relatively high. These will also be addressed further in Section 8 but, in brief, relate to:

a. RTF load. Whilst the RTF phraseology proposals had some demonstrable impact in mitigating RTF load in a Class G airspace aerodrome ATS environment, concern remained over RTF load in CAS and in the en-route phase of flight in Class G airspace; this concern was echoed by GA stakeholders at the Class G Airspace user workshop.

b. Increased workload for ATCOs in managing aircraft pressures and thus separating/deconflicting aircraft at ASR boundaries.

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[74] CAA, NATS, MOD (ATM and flight crew), Highlands and Islands Airports Ltd, British Airways, Eastern Airways, Flybe, Loganair, GA Safety Council, Aircraft Owners and Pilots Association, British Helicopter Association,British Business and GA Association, FlyOnTrack, PPL/IR Europe, Light Aircraft Association attended a Class G Airspace user workshop hosted by the Project at CAA House 31 March 2015.

5.47 Further evidence to satisfy the goal that the proposed State airspace, flight crew and ATC procedures have been validated (**G1.3.1.3.2**) will be the result from the 2nd State consultation, where all UK airspace stakeholders will have the opportunity to provide formal comment on all aspects of the proposal. However, given the evidence from safety analyses referred to above, at present, it is not possible to demonstrate that **G1.3.1.2.1** has been satisfied.

5.48 **Summary.** Whilst considerable progress has been made since the publication of the ISR in October 2014, safety analyses conducted by the Project partners have identified areas where further work is required to further validate and as necessary mitigate indicative risks on RTF load and ATCO workload. 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.

6 Transition, Implementation and Steady State

6.1 This section relates to the final 3 sections of the State Safety Argument, specifically that:

a. the civilian and military transition of the change and implementation is acceptably safe (**G2** and **G3** respectively); and,

b. the steady state operation is acceptably safe (**G4**).

6.2 Given that the focus of the Project thus far has been the development of CONOP V5.2 to inform the 2nd State Consultation and that the purpose of this SSAR is to assure that CONOP, understandably, little progress has been made in the transition and implementation of a raised TA and its steady state operation.

Transition and Implementation are Acceptably Safe (G2 and G3)

6.3 Direct responsibility for operational achievement of **G2** and **G3** rests with aviation stakeholders. However, State activities are required to facilitate a safe transition and implementation.

6.4 A workshop was held on 22 January 2015 at Aviation House to identify safety risks associated with the implementation of a harmonised, raised TA. Outputs from the workshop were:

a. **Implementation Timeline.** A TA Project implementation timeline has been created to highlight the State-level milestones that lead to the project 'O-Date', alongside indicative milestones for wider industry.

b. **Actions List.** A series of actions and their associated inter-dependencies were identified that would be required to successfully implement a harmonised, raised TA within the UK.

c. **Implementation Safety Risks.** A Generic high level safety risk related to the implementation of a raised TA was identified and is depicted below in Figure 11.

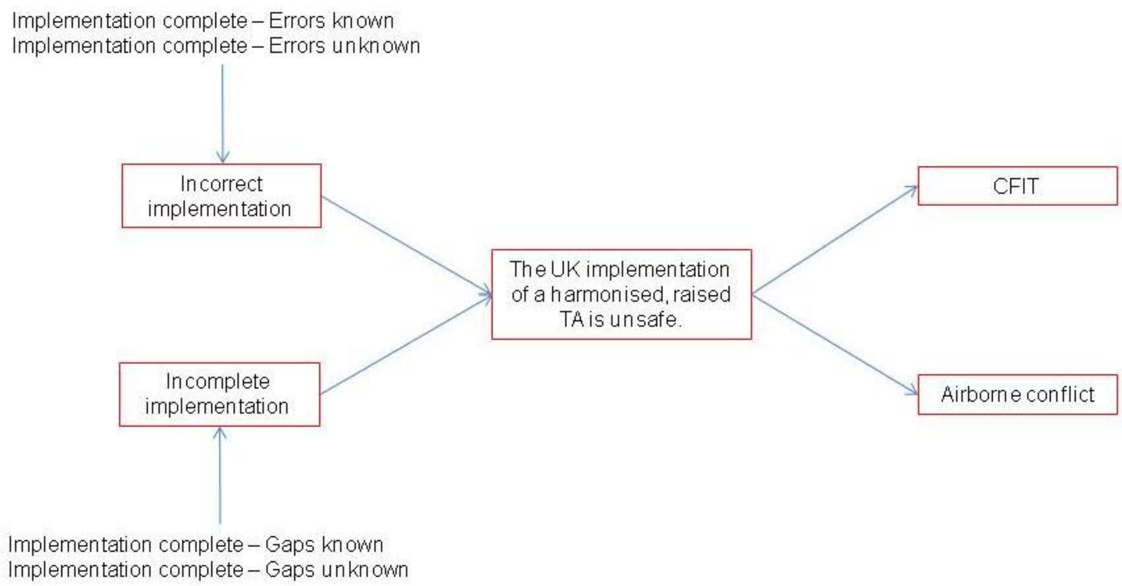

Figure 11. High-Level Implementation Safety Risk.

However it was felt that some additional detail was required to enable project stakeholders to understand how the actions required to mitigate the risk were attributed between the regulatory authorities and the operators/ANSPs. These lower-level yet generic implementation safety risks are shown in Table 4 below.

Serial	Description of Event	Event causes	Effect
1	The Regulatory authorities (CAA, MOD) fail to deliver an acceptably safe implementation of a harmonised, raised TA.	Insufficient information to regulated entities. Incorrect information to regulated authorities.	
2	ANSPs (civilian and military) fail to deliver an acceptably safe implementation of a harmonised, raised TA.	Insufficient information to ATCOs/FISOs. Incorrect information to ATCOs/FISOs.	CFIT Airborne Conflict
3	Aircraft operators (civilian and military)fail to deliver an acceptably safe implementation of a harmonised, raised TA.	Insufficient information to pilots. Incorrect information to pilots.	

Table 4. Generic Implementation Safety Risks.

Steady State Operation is Acceptably Safe (G4)

6.5 In order to determine that the steady state operation is acceptably safe, the Project will need to demonstrate that:

a. enhanced reporting, monitoring and trend analysis processes are in place; and,

b. a post implementation review process is in place.

6.6 Progress thus far on meeting these requirements has been limited to the proposal of a number of methods of post-implementation monitoring and agreement on the need to hold a dedicated post-implementation monitoring workshop which will:

a. Determine fallback/ fall forward options.

b. Develop and finalise post-implementation monitoring techniques.

7 Assumptions, Limitations and Issues

Assumptions

7.1 The following assumptions have been made in formulating the safety assurance analysis associated with the State TA Project:

a. That the risks associated with the current method of operations in UK airspace, including but not limited to the rate of TCAS events, are considered to be Tolerable and ALARP by both the State and operators.

b. That the ATM system utilises an assumed value of 27.3 ft per hPa irrespective of aircraft level and outside air temperature. However, ATS personnel will continue to utilise the value of 30 ft per hPa in 'operational' calculations associated with the assessment of vertical separation.

c. The UK Meteorological Authority has stated that there is an approximate 50:50 split between those occasions when atmospheric pressure variance within a defined area is lower than the pressure datum for that area. As an example, where variance was > 15 hPa on 0.04 % of observed occasions within the DONALD ASR, on 0.02 % of occasions the recorded pressure was lower than the ASR QNH value. However, data from the Met Office's North Atlantic & Europe limited area forecast model only shows the magnitude of any variance, it does not show its direction.

d. The UK Meteorological Authority has stated that the UK Met Office data set regarding the comparison of 169 aerodrome pairs is sufficiently representative of conditions experienced throughout the UK for conclusions to be drawn.

Limitations

7.2 The formulation of this safety assurance analysis has been limited by:

a. The phase of the project, in that it is anticipated that responses from aviation stakeholders to the 2nd State Consultation will form a significant element of validation evidence.

b. A lack of detail on the creation, format and promulgation of the ASR Bulletin, including the reliability and validity criteria that will be placed upon the data.

c. The scope of the the data from the Met Office's North Atlantic & Europe limited area forecast model which was extracted from the archive for the 5-year study period from October 2006 to September 2011 inclusive. Whilst it is reasonable to argue that the data sample is indicative of future weather conditions, it is not possible to state that the maximum pressure variances referred to herein have not been exceeded in the years preceding or following the sample time period.

Issue

7.3 From engagement with aviation stakeholders, the Project is aware of the widely accepted practise amongst some pilots operating within Class G airspace of using aerodrome pressure settings (QNH or QFE) away from the aerodrome traffic pattern, with the pilot applying corrections to avoid airspace infringement. Research undertaken by the Project determined that:

a. The variance between an aerodrome pressure and the 'local' atmospheric pressure observed within 40 nm of an aerodrome was ≤ 4 hPa on 99.4% of occasions and ≤ 4 hPa within 50 nm of an aerodrome on 98.8% of occasions.

b. The maximum observed variance within 30 nm of an aerodrome was 3.6 hPa, 4.4 hPa within 35 nm, 6.1 hPa within 40 nm and 6.2 hPa within 50 nm of an aerodrome.

7.4 As highlighted in paragraph 5.42 d, this variance across distance in atmospheric pressure can have implications for the overflight of airspace reservations and it is not known to what extent this effect is understood within the aviation community. CAA SARG should consider the results of this research undertaken by the Project in order to determine its effect on the Class G airspace user community.

8 Safety Risks and Benefits

Safety Risks

8.1 Safety Risks associated with the introduction of a harmonised and raised TA were developed initially from a series of hazard identification meetings and have evolved as further 'consequential' risks were identified. The risks were grouped in accordance with the following taxonomy:

a. **General.** Safety risks that are irrespective of airspace classification.

b. **Class G.** Safety risks that are related wholly to operations within Class G airspace.

c. **Controlled Airspace.** Safety risks that are related wholly to operations within controlled airspace.

d. **Implementation.** Safety risks that are related wholly to those implementation activities necessary to introduce a raised TA and an ASR system based upon 'actual' QNH values.

8.2 Although a formal 'bow-tie' analysis of the identified hazards has not been undertaken, an assessment was made of the potential 'accident sequences' that such hazards could be a part of. These hazards relate to multiple causal factors and progression to the outcomes identified would be subject to the failure of multiple barriers and mitigations, both extant and planned. However, in general terms, the principal safety outcomes that are related to these hazards are:

a. MAC and CFIT associated with increased pilot workload and RTF load, related to the increased number of altimeter setting changes.

b. MAC and CFIT associated with increased controller workload, related to the increased RTF load, increased number of altimeter setting changes and requirement for altimetry calculations to ensure aircraft separation.

c. CFIT associated with the atmospheric pressure gradient between the NASAS and the ASR boundary, the intra-ASR pressure gradient at ASR boundaries and a lack of clarity of appropriate QNH datum for flight.

d. MAC associated with airspace infringement, related to an increased complexity of mapping, lack of clarity of appropriate QNH datum for flight and the atmospheric pressure gradient between the NASAS and the surrounding airspace, in relation to the airspace reservation.

8.3 Given the difficulty in accurately assessing the severity and likelihood of these safety outcomes at a 'State' level using a typical risk classification system, the project developed a series of graduated 'confidence based' classifications. These classifications were based on an assessment of current and planned activity and whether that activity was sufficient to give the project confidence that the risk could be mitigated to a level that was considered acceptably safe. The classification of these individual risks is based upon subjective opinion and then validated through peer review by the TA Safety Committee and TA Project Team. This approach reflects previous similar, successful, applications of the methodology, such as London Olympic 2012 Safety, thus validating its use.

These 'confidence based' risk classifications are detailed below in Table 3:

	Colour Code		
	Green	**Amber**	**Red**
Confidence Factor	No safety concerns - actions are appropriate and timely to address the risks.	Safety Concerns - but current actions are considered appropriate to address the risks.	Significant Safety Concerns - additional action required - consider elevating the corresponding project risk.

Table 5. TA Project Safety Risk Confidence Descriptors.

8.4 Once identified, the risks were recorded within the project's Safety Risk Register, alongside the control measures that were identified as being required to mitigate the risk and a detailed log of actions necessary to deliver the mitigations; these actions being identified and agreed jointly by the TASC and TAPT. A table of the safety risks considered by the Project is at Annexe D which correlates the safety risk with the section of the State CONOP and this SSAR to which it relates.

8.5 Regarding the decision to initiate the 2nd State Consultation on the TA project, the TASG determined on 8 July 2014 that one of the go/no go criteria for that consultation will be that any risk being assessed as having a 'RED' confidence factor on the project safety risk register[75] would preclude consultation. At the time of writing, no safety risks were classified as 'RED' on the Project Safety Risk Register.

Safety Benefits

8.6 A clear safety rationale for the Project was identified; this being that a higher TA would enable Continuous Climb Operations, Continuous Descent Arrivals, Standard Instrument Departures (SID) & Standard Arrival Routes (STAR) to be programmed via an aircraft's Flight Management System. Such procedures would use advanced technology such as Area Navigation (Global Navigation Satellite System) (RNAV(GNSS)), thereby reducing the requirement for tactical intervention by ATCOs and thus reducing the risk of airborne conflict through pilot/ATCO error. However, in the context of FAS[76], in order to assess the safety risks associated with the introduction of a harmonised, raised TA within the UK, it is necessary to consider those risks in context with the safety benefits that are anticipated to be afforded by the change. A number of safety benefits were identified that are generic to the concept of a harmonised, raised TA and these are listed below:

a. That a raised TA 'shifts' the timing of altimeter setting changes to a phase of flight that is typically associated with lower levels of flight deck workload. This delivers a 'second order' benefit in that it reduces the risk of level-bust caused by flight deck errors in following altimeter setting procedures.

b. That multiple small changes of altimeter setting below the TA provide more opportunities for pilots and ATCOs to detect and correct errors in altimeter settings.

c. That a higher TA reduces the risk of level bust by 'designing out' the complexities in SID/STAR procedures that cause/contribute to level bust.

d. That go-around procedures will, in some cases, be simplified by a higher TA and thus reduce the risk of Loss of Control (LOC) incidents.

[75] Amongst the 'General', 'Class G airspace' and 'CAS' risks.
[76] 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.

e. That a harmonised TA across the UK reduces the complexity associated with multiple pressure datum reference systems, thereby reducing the risk of level bust.

8.7 Work conducted by NATS[77] however challenged the applicability of these benefits to the UK's implementation of a raised TA, determining that there was a "0 % potential quantifiable safety improvement from implementing the design at 18 000 ft". That said, it should be borne in mind that one of the purposes of the raised TA is to enable future airspace projects such as LAMP and NTCA, from which safety benefits are expected to be achieved. Moreover, attendees at a Class G workshop hosted by the CAA in March 2015 highlighted the following safety benefits directly associated with the UK State TA Project:

a. A raised TA removed the perceived complexity of operating on the Standard Pressure Setting from a majority of General Aviation operators.

b. The clear definition of CAS data and introduction of an altimeter setting that had relevance both to terrain and CAS was seen as reducing the risk of CAS infringement.

Residual Safety Effects

8.8 Evidence from the safety analyses conducted by NATS and MOD both indicated two specific issues where, at the time of writing, the level of indicative safety risk remained relatively high: RTF load, and controller workload at ASR boundaries. This is despite the successful development of the nominal VSM concept and RTF developments, as highlighted in paragraph 5.42 f/g. Consequently, RTF load and controller workload have been foremost in the safety analysis and considerations within the Project partner's own internal working groups, as well as part of the collaborative State TA Safety activity.

8.9 For those risks within CAS, as a joint Project partner, NATS have stated that, in conjunction with the capabilities provided by a new operating environment, the Project timelines will allow for the development of further mitigations against what they consider to be, at this stage, indicative risks. In addition, NATS aspire for further procedural and phraseology mitigations to be progressed through the Project's MOCOR framework. NATS also expect that the effectiveness of the mitigations on the indicative risks, and the impact of these mitigations in terms of cost and schedule, will become more mature within this timescale. The State TA Safety project expects that clarity on such mitigations and confidence in their ability to be delivered will be a key aspect of a decision by the CAA on implementation timelines following the 2nd State Consultation.

8.10 The CAA has also worked with the MOD in considering further the risk exposure, mitigations, and likely residual effects upon MOD stakeholders of the issues highlighted in paragraph 8.8. The findings of this work are summarised below:

a. **RTF load**. Whilst the RTF phraseology proposals had some demonstrable impact in mitigating RTF load in a Class G airspace aerodrome ATS environment, concern remained over RTF load in CAS and during the en-route phase of flight in Class G airspace; this concern was echoed by GA stakeholders at the Class G Airspace user workshop. This concern is mainly caused by the increased length of RTF[78] transmissions for climb and descent instructions in the expanded volume of airspace within which altitudes will apply, which would result in additional controller workload.

(i) **Mitigation.** Additional mitigations are being considered by the joint Project partners; however, it is expected that adaptation of behaviours by ATS personnel through ANSP implementation training activity and increased experience of operations with a raised TA will play a considerable role.

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[77] Revised Common Transition Altitude Safety Benefits Analysis – Repeat Workshop Issue 2 dated November 2012.
[78] For example "climb to altitude one four thousand feet, QNH nine-nine-one hectopascals"; albeit that the provision of a QNH value is only required on initial setting and following an update to the value.

(ii) **Residual effect.** Despite these mitigations, it is acknowledged that there will be an inevitable increase in RTF load as a result of a raised TA. In order to manage workload and maintain safety levels there is the potential for service refusal or denial of coordination requests to aircraft in Class G airspace. Within CAS, there is an ability to manage the flow of traffic through sectors. Therefore, for this particular risk it is proposed that the effect is likely to be manageable without notable safety impact.

b. **Controller Workload.** MOD concerns on the risk of increased controller workload are caused by 2 specific issues affecting their 'area'[79] controllers and are observed predominantly in the Class G airspace environment:

(i) The ability of controllers to correctly assess the vertical position of a conflicting aircraft in an adjacent ASR – due to the effects of both RDPS processing and altimeter setting changes on changing ASR – in order to provide accurate traffic information and/or appropriate deconfliction advice.

1. **Risk Exposure.** Exposure to the risk is managed through the following factors:

- Typically, Weapons Controllers (WC) will not provide a DS;

- Typically 'area' ATCOs will only provide ATS above 10 000 ft.

- WCs provide ATS utilising RDPS that do not correct for multiple ASR QNH data and are thus only exposed to changes in aircraft SSR pressure altitude report introduced by changes in aircraft altimeter setting.

2. **Mitigation.** Additional technical mitigations are being considered for deployment at RAF Unit Swanwick, alongside the use of other procedural mitigations; however, it is expected that adaptation of behaviours by ATS personnel through ANSP implementation training activity and increased experience of operations at ASR boundaries will play a considerable role.

3. **Residual effect.** Despite the potential mitigations, there is an acknowledged increase in mental workload for the control of those aircraft under Deconfliction Service. The effect for those aircraft under Traffic Service is considered to be slight. In order to manage workload there is the potential for an increase in service refusal or denial of coordination requests to aircraft in Class G airspace. Therefore, it is felt that, for this particular risk, the effect is likely to be manageable by ANSPs; however, there is an unquantifiable 2nd order effect on overall aviation safety in Class G airspace..

(ii) The ability of an 'area' ATCO to achieve vertical coordination involving an aircraft manoeuvring within multiple ASR, for example conducting Air Combat Training or General Handling, in receipt of an ATS from a WC. The risk is caused, in part, due to the differing methods of operation utilised by both controllers. A particular challenge to address will be mitigating the effects of updates to the ASR QNH during the period of the coordination agreement, given that the operation may encompass multiple ASRs.

1. **Risk Exposure.** Exposure to the risk is managed through the following factors:

[79] This term is used to refer to both Air Traffic Controllers (ATCO) and Aerospace Battle Manager Weapons Controllers.

- Only applicable to those aircraft in receipt of a Deconfliction Service.

- It is not applicable to aircraft operating within segregated airspace;

- WCs have some experience of making altimetry calculations; however wider utilisation of this skill will be required following TA implementation.

- Issue is focussed on activities undertaken in un-segregated airspace, mainly in the North and East of England and Scotland.

- The hourly atmospheric pressure change is within ± 1 hPa for locations within the UK FIRs on 90-96 % of occasions[80].

2. **Mitigation.** Whilst additional procedural mitigations are possible, it is expected that adaptation of behaviours by ATS personnel through ANSP implementation training activity and increased experience of operations at ASR boundaries will play a considerable role.

3. **Residual effect.** Despite the potential effect of additional mitigations, there is an acknowledged increased in mental workload. In order to manage workload there is the potential for an increase in service refusal or denial of coordination requests to aircraft in Class G airspace. Therefore, it is felt that, for this particular risk, the effect is likely to be manageable.

8.11 It is undeniable that the implementation of a raised TA and the associated introduction of new ASRs based on 'actual' QNH values will introduce increases in RT load and mental workload on MOD stakeholders. The challenge has been to identify their extent and tolerability within the total system and whether their effect can be managed to ensure appropriate levels of safety. Overall, it is proposed by the State TA Safety Project that these safety risks can be managed by ANSPs; however, the potential 2nd order safety effects of increases in service refusal to aircraft in Class G airspace and reduced accommodation of coordination requests cannot currently be quantified. These effects are likely to be most pronounced in the immediate transition to a raised TA and are likely to reduce through adaptation and normalisation in time. However, as part of implementation activity, aviation stakeholders should collectively address this aspect, in particular to take appropriate steps to mitigate the impact for off route GAT, especially where there are limited or no other routings available.

Summary

8.12 Whilst the identification of safety benefits by the Class G airspace workshop attendees was welcome, it is reasonable to argue that these benefits are limited in their scope. Moreover, work conducted by NATS has indicated that, in relation to their operations inside CAS, no safety benefits will be achieved directly from the implementation of a harmonised, raised TA of 18 000 ft. Furthermore, NATS and MOD have indicated that, at the time of writing, the level of indicative safety risk in two areas remains relatively high: RTF load, and controller workload at ASR boundaries. This view was supported by attendees at the Class G airspace user workshop hosted by the CAA in March 2015.

[80] The UK Meteorological Authority has stated that "following a review of 9 locations in the UK (Ballykelly, Bridlington, Carlisle, Hurn, Kinloss, Langdon, Lerwick, St Mary's, and Stornoway), it was noted that the hourly atmospheric pressure change within ± 1hPa occurs on 92-96% of occasions. Having reviewed the data and considered the location of the proposed NASAS, it is the view of the CAA that the hourly atmospheric pressure change within ± 1 hPa for locations within the UK FIRs would be 90-96 % of occasions"

9 Conclusion

9.1 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 risk.

9.2 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. Given that the ASR design and proposed State airspace, flight crew and ATC procedures may be refined in light of consultation responses, it is understandable that, at this stage of the project, this validation has yet to be completed. However, activity is underway for this to be delivered within the anticipated timeline.

9.3 It is reasonable to argue that a sufficient level of maturity exists within the ASR design, given that it is based upon design principles agreed between the joint partners and is the result of a series of development simulations and extensive negotiations with stakeholders. Furthermore, considerable progress has been made since the publication of the ISR in October 2014, in addressing issues identified within the report and in developing solutions, particularly regarding the use of an ASR QNH and aerodrome QNH in the calculation of an appropriate level for over flight of airspace reservations. That said, the balance of atmospheric pressure gradients within and between ASRs that is inherent to the design poses challenges to ATS providers in managing flights at ASR boundaries. 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.

9.4 Foremost within project stakeholder priorities are the residual safety effects of increased RTF loading and controller workload within CAS. Analysis has indicated that for MOD operations in Class G airspace, the risks can be managed; however, the 2nd order safety effect of the potential for increases in service refusal to aircraft and reduced accommodation of coordination requests cannot currently be quantified. Within CAS, whilst considered to be indicative, these safety risks remain of concern to the TASC and are categorised as AMBER on the joint Project Safety Risk Register.

9.5 In then considering the balance of safety risk versus benefit, whilst the identification of safety benefits by the Class G airspace workshop attendees was welcome, it is reasonable to argue that they are limited in their scope. Moreover, work conducted by NATS has indicated that, in relation to their operations inside CAS, no direct safety benefits will be achieved from implementing a harmonised, raised TA of 18 000 ft. However, in the context of the FAS directive on safety, the State will be required to determine whether there is at least a 'safety neutral' effect of the introduction of a raised, harmonised TA, in order to achieve benefits through the LAMP, NTCA and other future airspace projects. At the time of writing, based upon the indicative RTF load and workload associated risks and the potential 2nd order safety effects, it is not possible to argue with confidence that the proposed changes are at least safety neutral. Whilst the joint Project continue to work to identify and develop mitigations, given the proposed implementation timeline, gaining clarity on these mitigations and confidence in their delivery will be key in any decision by the Project to revise the safety risk classification, and by the CAA on implementation timelines.

9.6 Given the further 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. Specifically, how long can increases in safety risk be accepted, before the benefits achieved through future airspace projects can be realised?

The Maturity of Cross Organisational Relationships (MOCOR) Framework

The maturity of the working relationship required between the CAA and the organisations it regulates will vary from engagement to engagement. Maturity in this context refers to the depth and frequency of interactions between the CAA and the organisations, and therefore the amount of collaboration that is required and appropriate. The level of maturity is determined by the extent to which the CAA and the organisations' strategic goals are aligned and served by the production of common outputs. The type of relationship has implications for where the accountability for delivering outcomes lies, and for the governance arrangements and approach that is adopted to deliver projects. The MOCOR framework sets out three broad levels of maturity and the characteristics of the delivery activity expected in each. Any work completed under commercial arrangements is covered under the agreed commercial framework rather than MOCOR.

1 Core Regulatory Role (the norm)

- The CAA regulates the outputs generated by other organisations as and when they are required to.
- The CAA understands the interests of the organisations it regulates and balances them with those involved in or impacted by its regulatory decisions, to ensure deliverables are safe and efficient.
- Organisations regulated by the CAA understand its obligations, policies and regulatory processes.
- The CAA and the organisations it regulates work together to continually improve the effectiveness of regulatory processes.
- Due to potential conflicts of interest, lack of strategic priority or resource availability the CAA takes no accountability for the delivery of the desired outcomes.

2 Working in Collaboration (occasionally)

- **The CAA and organisations work in collaboration** to deliver desired outcomes through separate but co-dependent projects that are business planned jointly.
- **Projects have separate governance** along internal organisational lines but progress is reported regularly to an appropriate joint governance forum eg the FAS Programme Board.
- **Separate project managers are appointed** by the CAA and other organisations, with the responsibility to proactively sharing information and ensure alignment with their counterparts.
- **The CAA and other organisations take accountability for their outputs** and support the delivery of others, while respecting the obligations and constraints placed on the CAA when fulfilling its role as the regulator.

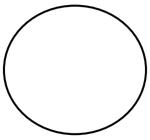
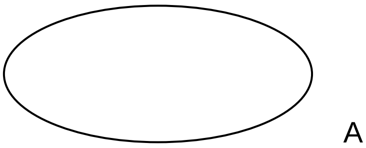
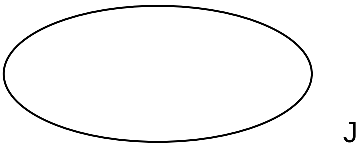
3 Working in Partnership (the exception)

- **The CAA and the organisation(s) take joint accountability** for delivering desired outcomes as a single project.
- **Cross organisational governance** arrangements are established to drive progress and to provide direction, challenge and assurance.
- **Additional Governance** will be required including 'sign-off' at an appropriate level and specific Terms of Reference.
- **One project manager** is appointed from one of the organisations involved in the project to take responsibility for managing delivery and reporting progress to the cross organisational governance forum on a regular basis.
- **Project team is established for the life** of the project, drawn from the CAA and the organisation(s) as appropriate.
- **Separate CAA regulatory resources** dedicated to regulating the outputs may be identified and attached to the project.

Annexe B Proposed UK Altimeter Setting Region Map[81]

[81] ASR Map Version 11, correct as of 24 August 2015.

Annexe C   A Guide to Goal Structuring Notation (GSN)

	The Goal - (a rectangle) the goal is the ambition that the safety argument or arguments are trying to satisfy. Goals can take the form of Safety Requirements or Safety Objectives. A Goal would normally appear at the top of the GSN diagram and there may be further sub-goals at a lower level that contribute to meeting the top-level goal.
	The Strategy - (a rhombus) the strategy would normally appear just below a Goal and will explain how the Goal will be demonstrated to be met.
	The Solutions (evidence) - (a circle) the solution normally equates to items or sets of evidence that demonstrate that the goal or sub-goal above is being met.
	The Assumptions - (an oval with an 'A' to the bottom right) the assumptions can be attached to any other shape and contain anything that has to be assumed for this argument to be valid.
	The Justifications - (an oval with a 'J' to the bottom right) the justifications can be attached to any other shape and contain the reasoning behind the content of the associated shape.
	The Context - (a curved sided rectangle) the context can be attached to any other shape and contains the operational environment for which this argument is valid.

Solution Colour Coding	
Colour	**Meaning**
RED	Indicates that work has not yet begun on satisfying a goal or providing specific evidence/solutions.
AMBER	Indicates that work to satisfy a goal, or deliver a piece of evidence/solution has begun but is not yet complete.
GREEN	Indicates that the goal has been satisfied or that a specific piece of evidence/solution has been completed that, in part, satisfies a goal.

Annexe D Meteorological Data

ASR	CORNISH	AVON	LONDON	POTTER	ANGLIAN	KELVIN	LINDI	GORDON	ODIN	FRASER	DONALD
Maximum pressure difference (hPa) from NASAS to all points in the ASR	16.55	13.23	12.31	10.33	9.95	17.24	13.55	18.78	20.73	18.44	24.13
98th Percentile of maximum pressure difference (hPa) from NASAS to all points in the ASR	8.08	7.72	6.47	6.78	5.88	9.65	7.51	9.02	9.57	9.75	9.36
% of occasions where maximum pressure difference from the NASAS to all points in the ASR is > 15 hPa	0.06	0	0	0	0	0.08	0	0.06	0.10	0.11	0.04
% of occasions where maximum pressure difference from the NASAS to all points in the ASR is > 15 hPa **and** lower than ASR datum	0.03	0	0	0	0	0.04	0	0.03	0.05	0.06	0.02

ASR	KILDA	CORMO	MILLA	FULMA	MURDOCH
Maximum pressure difference (hPa) from NASAS to all points in the ASR	25.16	20.97	13.95	9.88	13.42
98th Percentile of maximum pressure difference (hPa) from NASAS to all points in the ASR	9.53	11.52	6.40	5.79	7.14
Frequency of occasions where maximum pressure difference from the NASAS to all points in the ASR is > 15 hPa	0.15	0.21	0	0	0
Frequency of occasions where maximum pressure difference from the NASAS to all points in the ASR is > 15 hPa **and** lower than ASR datum	0.08	0.11	0	0	0

Annexe E Safety Risk Correlation to CONOP and SSAR

General Project Safety Risks					
Description of Event (What?)	**Causes (Results in?)**	**Effect (And Leads to?)**	**Desired Outcome (Evidence required to show the following)**	**CONOP Reference**	**SSAR Reference**
Lateral ASR boundaries inappropriate for normal flight paths, airspace structures etc	Increased ATC and pilot workload	Airspace infringement - airborne conflict	ASR boundaries designed in so far as possible to take account of all aviation activity Analysis and argument in support of where boundaries in Class G airspace affect identified aircraft operations included in State consultation	5.1	5.20 to 5.25 5.27 to 5.28
Inappropriate naming of ASR regions	Confusion and mix up on datum used	Airspace infringement - airborne conflict Loss of terrain clearance	Clarity of data and naming Analysis and argument of pros and cons in support of ASR naming in State consultation ASR naming that is appropriate and safe on RT	5.2	5.26 5.29
Unavailability of SPECI data in ASR	Variance between ASR and actual QNH	Controller/pilot confusion and increased workload	Clarity of accuracy of ASR CONOPs ensure clarity between ATS units as to the QNH value	5.5	5.20 5.42g 5.42 i

Description of Event (What?)	Causes (Results in?)	Effect (And Leads to?)	Desired Outcome (Evidence required to show the following)	CONOP Reference	SSAR Reference
Loss of forecast QNH to autonomous users (including pre-flight unavailability for users away from AFTN)	Flight without accurate QNH datum	Possible airspace infringement Possible terrain clearance reduction	Clarity of intrinsic rather than theoretical risk and appropriate mitigation procedures in CONOPs ASR data freely and openly available on internet Argument of adequacy of ASR availability in consultation document	TBD	5.42 i
Lack of clarity of QNH datum for CTR/CTA versus TMA and airways	Mapping complexity Reduced vertical containment inside CAS	Airspace infringement - airborne conflict	CONOPs ensures that pilots have clarity and certainty of which QNH applies	5.7	5.42 c
Loss of RPS for accurate over /under flight of airspace reservation - includes ATC directed in CAS off route	Inappropriate QNH for airspace infringement protection - airspace reservations with a defined vertical limit (eg small arms ranges and air weapons ranges etc)	Airspace Infringement - aircraft contact with range projectile Airspace Infringement - Airborne conflict with range aviation activity	Appropriate supporting system in CONOPs to ensure airspace infringement risks are mitigated	7.3, 7.7, 8.2, 8.3	5.42 d

Description of Event (What?)	Causes (Results in?)	Effect (And Leads to?)	Desired Outcome (Evidence required to show the following)	CONOP Reference	SSAR Reference
Raised TA generates complexity with DFL195 where Class C abuts Class G airspace	Pilot and Controller workload complications	Infringement of Class C airspace Unavailability of FL200 on limited occasions	Simple clear airspace delineation and interface of DFL195 with 18 000 ft TA Issue articulated in State consultation	6	5.42 a
RDPS depictions (Area QNH) at variance to actual (Airport QNH) set on aircraft or vice versa	Controller workload and potential confusion	airborne conflict	Controller clarity on actual separation between aircraft and datum depicted RDPS issues articulated in CONOPs and State consultation	8.3 to 8.5	5.42 h
Use of QNH Tolerance	Highlights 'nominal' Vertical Separation Minima Misapplication of Tolerance cruising 500ft above BoCAS	Increased incidence of ACAS events. Increased severity of level bust incidents.	Acceptable State safety argument defined for the use of the concept	9.2 to 9.9	5.42 f
Use of Broadcast QNH	Possible pilot confusion over correct pressure setting.	airborne conflict	Use of broadcast QNH is an approved procedure under defined circumstances and is well communicated to the user audiences Approved procedure for ATC not to check in the absence of/ failure of Mode S/ BAT safety net tools as correct QNH setting is a pilot's responsibility	8.8	Not applicable

Description of Event (What?)	Causes (Results in?)	Effect (And Leads to?)	Desired Outcome (Evidence required to show the following)	CONOP Reference	SSAR Reference
Availability of ASR QNH to pilots	Flight without accurate QNH datum	airborne conflict CFIT	ATSUs are able to provide pilots with ASR QNH values appropriate to their area of operation	TBD	5.42 i
Use of 'when ready' prefix in climb/descent clearances	Confusion and mix up on datum used	Increased incidence of ACAS events Increased incidence of level bust incidents	Altimeter Setting procedures that mitigate the risk of level bust when used in association with 'descend when ready' clearances	Not applicable	5.42 g

Class G Airspace Project Safety Risks					
Description of Event (What?)	**Causes (Results in?)**	**Effect (And Leads to?)**	**Desired Outcome (Evidence required to show the following)**	**CONOP Reference**	**SSAR Reference**
Loss of RPS for terrain accuracy	Inappropriate QNH for terrain clearance use Reduced terrain separation	CFIT Flight in Icing	Appropriate supporting system in CONOPs to ensure terrain risks from loss of RPS are mitigated	7.3, 7.7, 8.2, 8.3	5.42 d
Introduction of additional QNH and increased volume of airspace in which altitudes apply	Increased workload - ATC and pilot errors Incorrect QNH settings Complications in ATC unit/unit coordination	Airborne conflict	Consultation includes evidence and argument that workload is not increased in Class G airspace	8 and 9	8.8 to 8.11
Gradient between ASR regions in Class G airspace - both controlled and autonomous flights	Increased workload - ATC and pilot errors	airborne conflict	Aircraft transitioning boundaries are not subjected to excessive pressure gradients	5	5.27 to 5.28 5.34 8.10 b

Description of Event (What?)	Causes (Results in?)	Effect (And Leads to?)	Desired Outcome (Evidence required to show the following)	CONOP Reference	SSAR Reference
FIR boundary interfaces	Increased workload - ATC and pilot errors	airborne conflict	Airborne conflict potential at FIR boundaries minimised Procedures articulated in CONOPs	8 and 9	5.45
Continued use of Lowest Forecast Pressure (LFP)	Pilot workload complications. Possible controller confusion over correct pressure setting Inappropriate use of LFP by civilian airspace users.	Possible airspace infringement. Possible terrain clearance reduction	Provision and use of LFP invisible to civil airspace users and ATS providers Risk of airspace infringement is reduced to Tolerable and ALARP. Risk of CFIT is reduced to at least Tolerable and ALARP	9.17	5.42 e

Controlled Airspace Project Safety Risks					
Description of Event (What?)	**Causes (Results in?)**	**Effect (And Leads to?)**	**Desired Outcome (Evidence required to show the following)**	**CONOP Reference**	**SSAR Reference**
Introduction of additional QNH and increased volume of airspace in which altitudes apply	Increased RT workload - ATC and pilot	Controller overload and detraction from core task Incorrect QNH settings Complications in ATC coordination	Maintain controller and pilot capacity CONOPs and Consultation has clarity on RT procedures and effects on workload	8 and 9	5.42 g 5.46 8.8 to 8.11
Introduction of additional QNH and increased volume of airspace in which altitudes apply - associated pressure calculations	Increased ATC mental workload	ATC errors - airborne conflict	Maintain controller capacity CONOPs and Consultation has clarity on RT procedures and effects on workload	8 and 9	8.9
Introduction of additional QNH and increased volume of airspace in which altitudes apply - increased numbers of pressure changes	Increased pilot workload	Pilot errors	Maintain pilot capacity CONOPs and Consultation has clarity on RT procedures and effects on workload	8 and 9	5.42 d 5.42 e 5.42 j 8.10

Description of Event (What?)	Causes (Results in?)	Effect (And Leads to?)	Desired Outcome (Evidence required to show the following)	CONOP Reference	SSAR Reference
Gradient between ASR regions in CAS	Increased workload - ATC and pilot errors	airborne conflict	Procedures and processes in CONOPs that assure separation at and in vicinity of ASR boundaries	5	5.27 to 5.28 8.9
FIR boundary interfaces	Increased workload - ATC and pilot errors	Airborne conflict	CONOPs FIR boundary interface procedures assure separation at and in vicinity of FIR boundary	5	8.9 8.10
Pressure differences between adjacent aerodrome QNHs	Procedures that deem differing QNH as being one and the same Reduction in airspace containment	Airborne conflict	Appropriate balance of safety on compliance with normal practice versus excessive ATC and pilot workload Enabling current and future capacity without excessive QNH changes to be required Develop nominal airspace containment for future IFP design Facilitate the continued approval of legacy arrangements	9	5.42 f 8.9
Military crossing of CAS with multiple ASR boundaries	Increased workload or incorrect QNH	Airborne conflict	Enduring OAT crossings of CAS without undue additional workload Revised procedures and processes in CONOPs	5 and 10	5.42 f

Description of Event (What?)	Causes (Results in?)	Effect (And Leads to?)	Desired Outcome (Evidence required to show the following)	CONOP Reference	SSAR Reference
Raised TA generates complexity with the base of an active TRA where it abuts a Class E airway	Pilot and Controller workload complications Confusion over Airspace classification	Infringement of Class E airspace Possible unavailability of lower levels of TRA on limited occasions	Simple clear airspace delineation and interface of upper limit of Class E airway and the base level of a TRA	6.3	Not applicable