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

CONOPS - Joint Concept of Operations for Inside and Outside of Controlled Airspace

CAP 1349 - 7

Policy to Introduce a Harmonised Transition Altitude in the London and Scottish Flight Information Regions

Joint Concept of Operations for Inside and Outside of Controlled Airspace

20151102-VERSION 5.2

Publication History

Version	Date	Details
1.0	1 May 13	First Issue
2.0	1 Sept 13	Post 1st Review
2.1	10 Oct 13	Post TAPT and TASG Review
2.2	18 Dec 13	Post Class G Internal Workshop
3.0	3 Mar 14	Integration of CAA, NATS and MOD comments
3.1	13 Mar 14	Integration of TASC Comments up to Section 10
3.2	3 Apr 14	Integration of TASC and TAPT Comments – whole document
3.3	10 Apr 14	TASC peer review of v3.2
3.4	28 Apr 14	Integration of TASC Comments and Review
4.0	11 Sep 14	Coordination update
4.1	24 Feb 15	Project Progression Update
4.2	9 Mar 15	Project Progression Update
4.3	18 Mar 15	Project Progression Update
4.4	17 Jun 15	Project Progression Update
4.5	1 Jul 15	Project Progression Update
5.0	20 Jul 15	Project Progression Update for 2nd State TA Consultation
5.1	1 Oct 15	Project Progression Update for 2nd State TA Consultation
5.2	2 Nov 15	Project Progression Update for 2nd State TA Consultation

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1 INTRODUCTION

1.1 A harmonised Transition Altitude (TA) of 18,000ft is proposed with the intention of enhancing efficiency, both inside and outside controlled airspace, through 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 Flight Information Regions (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), Future Airspace Strategy (FAS) and the UK/Ireland Functional Airspace Block (FAB).

1.2 Information Notice-2014/033 articulated the UK/Ireland FAB position on a higher TA and also the European position at that time. Since the launch of the first UK consultation, the European Aviation Safety Agency (EASA) has conducted an initial consultation on a harmonised TA in line with the European Commission Rulemaking Procedure. The following regulatory options were identified and considered:

a. Option 1 – Do nothing (i.e. no regulatory intervention).

b. Option 2 – An Implementing Rule (IR) to implement a harmonised European TA at 18,000ft.

c. Option 3 – An IR prescribing common criteria for the determination of the TA at or above 10,000ft.

1.3 EASA set up a Harmonised European Transition Altitude (HETA) Rulemaking Group to determine the European position. The HETA Group determined there should be no regulatory intervention, although it felt that EASA should issue guidance to States wishing to change their TAs in the future. In due course it is anticipated that these findings will be ratified by the SES Committee.

1.4 A decision was made by the Future Airspace Strategy Deployment Steering Group in December 2013 to proceed to a second State TA Consultation with a Concept of Operations (CONOPs) developed to support a level of 18,000ft. As the European project timescales did not suit the aspirations of the UK, Ireland and Norway, the three States had to proceed with their plans before the European position was clear. The UK, Ireland and the Isle of Man have therefore announced their intent to implement an 18,000ft TA at the same time and based on the same high level CONOPs. Norway has also indicated its intention to adopt a TA of 18,000ft although their timescales for consultation and implementation are yet to be confirmed.

1.5 Raising the TA presents significant challenges, requiring a mind-set change for pilots and controllers 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 mitigated. However, a long lead in time to implementation should ensure that all such concerns are managed in an appropriate and timely manner.

2 GOVERNANCE

2.1 A joint CAA, NATS and MOD TA Project Team (TAPT) has been established, working in partnership to develop and implement a common TA of 18,000ft across the London and Scottish FIRs. A State TA Safety Committee (TASC), primarily formed of the CAA/NATS/MOD project partners, has been established to ensure that safety is appropriately assured. The TASC operates parallel to, and in cooperation with, the TAPT and both report directly to the TA Steering Group (TASG). The TAPT and TASC will be established for the life of the Project.

2.2 The TASG provides cross-organisation governance arrangements to drive progress and to offer direction, challenge and assurance. The TASG also provides input into the UK-Ireland-Norway TA Oversight Group (UINTAOG) that reports to the FAB Supervisory Committee. The TAPT, TASC, TASG and UINTAOG all have representation from the CAA, NATS and MOD.

3 NOTIFICATION

3.1 The CONOPs describes the high-level characteristics for the proposed harmonised raised TA in the London and Scottish FIRs and should be considered as a baseline for the evaluation of procedures to be used.

4 DEFINITION OF TRANSITION ALTITUDE

4.1 ICAO definition (Doc 8168 Annex 2; Chapter 1): Transition Altitude (TA) - the altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes. The current UK and European interpretation, in operational use in most countries, is that the TA is defined in whole thousands of feet (e.g. 6,000ft and below in the London and Scottish TMAs) and the vertical datum is based on QNH. Above the stated TA, Standard Pressure Setting is used.

5 ALTIMETER SETTING REGIONS

5.1 An element of the TA project is the replacement of the existing Regional Pressure Setting Regions, which currently use a forecast of the lowest pressure, with new Altimeter Setting Regions (ASRs) which will use an actual QNH value. The concept of ASRs has been developed to define regions where, below 18,000ft, a single QNH value per ASR will be defined within the Air Traffic Management (ATM) system for use within en route Controlled Airspace (CAS). Within Class G airspace the use of ASR pressures is recommended for en route flights whenever the use of an airfield datum would be inappropriate. In order to provide a consistent approach to ASR design, a number of principles were established governing their physical and meteorological characteristics.

a. **Minimum Number of ASRs.** In order to minimise the number of ASRs, the size of the ASRs should be as large as possible in order to be operationally viable within CAS, yet sufficiently small to ensure that the pressure differences within and between ASRs is as low as practicable. This is for two reasons, firstly the magnitude of pressure differences between two locations is a function of distance, i.e. the further apart two locations are, the larger the surface pressure difference is likely to be. The second reason is that the frequency of pressure differences between two locations is a function of distance, i.e. the further apart the two locations are, the greater the likelihood that there will be a difference in pressure.

The Met Office undertook a number of studies to assess these two issues, so the information could be used to establish how large the areas should be before the intra-regional and inter-regional differences became significant. These studies indicated that pressure variances are lower in the south than in the north of the UK, and tended to vary less from east to west than north to south.

Large pressure variations only occurred on a small number of occasions (~2%) usually associated with deep depressions that moved rapidly across the UK. Therefore it was agreed to base the design of the ASRs on data up to the 98^{th} percentile, i.e. ignoring the occasions when large pressure differences occur. Where exceptional variation occurs associated with 2% of observations, these events can be clearly associated with storm features which for the most part preclude or severely restrict flight.

Subsequently the design criteria was set to ensure that, based upon historical data, the variation within each ASR shall not be greater than 15 hPa based on a 98% probability. This design criterion allows suitable calculations to be made that ensure safe overflight of terrain and airspace reservations. (See Sections 7 & 8). Following further investigation, it can be demonstrated that for 99.79% of occasions for all ASRs, and 99.99% of occasions for ASRs over the land, that pressure variation is below 15hPa as measured from the reporting station to all points within the ASR.

b. **Common Boundaries.** The areas would utilise common vertical and lateral boundaries, irrespective of the classification of airspace, thus avoiding the situation where differing QNH values would exist within each ASR inside and outside CAS. The boundaries would coincide with existing airspace structures where possible.

5.2 Each ASR will have a Nominated Altimeter Setting Aerodrome or Station (NASAS), detailed at Annex B. The QNH will be extracted from the METAR and this value will be promulgated in the routine half-hourly ASR Bulletin. Air Navigation Service Providers (ANSPs) are to disseminate ASR QNH values relevant to their area of operation to controllers for onward and timely dissemination to aircraft operating on an ASR QNH. The selection criteria for each NASAS were:

a. The distance between NASAS should be no more than 150nm where operationally possible.

b. The identification of a major aviation hub, thereby minimising the number of altimeter setting changes within the specific ASR.

c. The ability, where possible, to supply METARs on an H24 basis.

d. Ideally, to be as centrally located as possible within each ASR in order to reduce the inter-regional differences. However because there are a limited number of aerodromes capable of issuing METARs on an H24 basis some non-centrally located NASAS have been chosen.

5.3 To avoid risk of confusion between pressure settings used for takeoff and landing, and that used within the area, where practicable ASRs have been named independently from the NASAS from which the ASR QNH is derived, based upon principles detailed in the ASR Naming Policy developed by the CAA. For example, the QNH provided by the Newquay NASAS is proposed to be called the Cornish QNH. An ASR QNH bulletin, derived from the METAR process, will be issued by the Civil Aviation Communication Centre (CACC) on a half-hourly basis for promulgation by Aeronautical Fixed Telecommunication Network (AFTN).

5.4 The UK Met Office will routinely provide a back up pressure for each ASR and in the event of a NASAS not issuing a METAR, or should the METAR not contain a valid QNH, a back-up ASR QNH will be issued based upon a predicted QNH[1] for the same location. Additionally, a predicted QNH will be provided for any areas where there is no capability to produce an actual QNH, such as the Donald area north of the Outer Hebrides. Predicted ASR QNH values will be transparent to, and have no impact on the user. Back up arrangements will be established by CACC and the UK Met Office to ensure that the provision of ASR QNH values will be maintained.

5.5 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 caused by multiple pressure changes. For this reason, the relevant NASAS aerodrome QNH may be different to the ASR QNH. Where a NASAS aerodrome QNH changes by 2hPa within the METAR cycle, an interim ASR bulletin will be issued; this will facilitate the management of altimeter settings for aircraft operating in accordance with QNH tolerance procedures (see Section 9.2). For this reason, the relevant NASAS aerodrome QNH may be different to the ASR QNH.

5.6 When the atmospheric pressure is forecast to change by ≥2hPa in the next METAR cycle, or there is a large pressure gradient forecast (≥6 hPa) across an ASR, the ASR QNH bulletin will contain a warning to alert users. Details of procedures to be adopted are defined at paragraphs 7.2, 7.3 and 8.2.

[1] Met Office data shows that for a number of locations across the UK, for the locations verified, 99.2 % or more of forecasts of QNH are within +/- 1.5 hPa of the actual value at up to 3 hours ahead.

5.7 The promulgated ASR QNH will be the altimeter setting value used to define the upper and lower boundaries of en route CAS below the TA including TMAs and some CTAs[2]; however, the upper and lower boundaries of CTRs and CTAs associated with an aerodrome will be based on the aerodrome QNH of the controlling authority[3]. CAS bases in adjacent FIRs will remain unchanged[4]. Details will be promulgated in the AIP[5].

Figure 1 overleaf is a chart showing the proposed ASRs.

[2] In addition to airways, the CTAs below the TA which will be defined by the ASR QNH are the Clacton, Cotswold, Daventry, North Sea, Severn and Worthing CTAs. The North Sea CTA (2 & 3), is dependent on final arrangements with the Netherlands. Strangford CTA arrangements are to be confirmed.
[3] This includes Solent CTA, which is based on Southampton QNH.
[4] In areas of UK CAS where ATS is delegated to another ANSP, discussions are still ongoing.
[5] The CAA is considering the current CTA naming and the need to regularise any variances.

Fig 1. Proposed Altimeter Setting Regions for the UK & Ireland[6].

[6] The airspace at the far northeast section of the chart represents the Norwegian and Icelandic FIRs within which ATS is delegated to the UK up to FL85.

6 RELATIONSHIP BETWEEN TRANSITION ALTITUDE, CLASS C AIRSPACE (FL195 AND ABOVE), TEMPORARY RESERVED AREAS AND THE LOWEST USABLE FLIGHT LEVEL

6.1 Due to the close proximity of the planned TA of 18,000ft and FL195 (the defined base of Class C airspace) and the base of many Temporary Reserved Areas (TRAs), very low pressure can present overlap issues. Airspace at and above FL195 is always Class C or TRA, irrelevant of the Class of airspace below and the effects of very low pressure.

6.2 Where Class G airspace is situated immediately below FL195 and the pressure is 959hPa or below[7], pilots flying at the TA of 18,000ft would be infringing Class C airspace or potentially an active TRA as 18,000ft would be at or above FL195. It is the pilot's responsibility to remain clear of CAS or an active TRA; however, this low pressure will be notified through a Met warning.

6.3 18,000ft will always be available within CAS, with the exception that where Class E airspace vertically abuts an active TRA, it is the responsibility of the ANSP to ensure effective separation from the TRA. FL190 will not be available for flight planning purposes throughout the UK FIR. This is because at any pressure below 1014hPa, FL190 does not provide standard separation against 18,000ft; however FL190 will be available tactically as directed by the ANSP.

Where Class A/D airspace is situated immediately below Class C airspace and the pressure is 977hPa or below, the ANSP will make FL200 unavailable; thus FL210 would be the lowest available Flight Level. Where Class C airspace lies above Class G airspace, FL200 will always be available. Pilots within Class G airspace are to be aware of the requirements of paras 7.2 and 7.3. Examples of the percentage of occasions that low pressure values have occurred at 3 NASAS aerodromes are shown in Table 1 below.

	Heathrow	Manchester	Glasgow
1013 to 996	37.7%	41.1%	41.9%
995 to 978	5.2%	8.2%	11.0%
977 and below	0.2%	0.4%	1.0%

Table 1. Examples of Percentage of Occasions that Low Pressure Has Occurred. (Source: Data from the Met Office's North Atlantic & Europe limited area forecast model 5-year study period from October 2006 to September 2011 inclusive).

6.4 With the introduction of an 18,000ft TA, there is a requirement to amend the published bases of airspace and routes where they are currently defined as Flight Levels at or below FL180. Therefore, where bases are currently defined at FL175 and below, they will change to altitudes of 17,500ft and below[8]. Similarly, where minimum cruising levels on certain

[7] This is based on the ICAO values and differs from the rule of thumb where 1hPa will be considered to be equivalent to 30ft.
[8] In areas of UK CAS where ATS is delegated to another ANSP, discussions are still ongoing.

routes are currently published as a Flight Level at or below FL180, these will be redefined as altitudes at or below the TA of 18,000ft[9].

6.5 Within UK airspace, where TRAs and TRA(G)s (for gliders) have been established between FL195 and FL245 to facilitate autonomous VFR flight, aircraft will be able to access these areas during notified periods of activity irrespective of pressure differentials. A raised TA does not change the conduct of operations within an active TRA or TRA(G).

7 PILOT OPERATING PROCEDURES

Pre-Flight Planning

7.1 Depending on when the planning process takes place, the actual ASR QNH expected during flight may not be known. When flying in airspace below TMAs and CTAs not directly associated with an aerodrome (see paragraph 5.7), pilots who choose not to utilise the ASR QNH should use the QNH of an adjacent aerodrome[10] when flying at or below the Transition Altitude; however pilots should be aware of the potential variance between the aerodrome QNH and the ASR QNH and the associated risk of airspace infringement. Pilots operating close to the base of an airway are recommended to set the ASR QNH and to select an appropriate cruising level to avoid inadvertent airspace infringement. Caution should also be exercised in the vicinity of ASR boundaries as the QNH of an adjacent ASR could vary considerably from the QNH the aircraft is utilising.

7.2 **Terrain/Obstacle Clearance.** En Route Safety Altitude should be established by pilots during the planning process in order to reduce workload at a critical stage of flight. It is based on the highest ground or obstacle in a region or along the predicted route of the flight. Due to known pressure variance within ASRs, pilots should be aware that use of an ASR QNH may not necessarily guarantee achievement of the AMSL based safety altitude. Consequently, it is advisable that during the planning process and during flight an additional 200ft is added to any calculations for terrain/obstacle clearance whilst utilising the ASR QNH. When a warning is included in the ASR bulletin (see para 5.6) indicating a pressure gradient across the ASR of ≥ 6hPa, an additional 300ft should be added making a total of 500ft to cater for the most significant cases of variance. Where this action conflicts with other airspace reservations, pilots must either request a crossing clearance or re-route around the airspace reservation. Where headings and levels are allocated by ATC, such instructions will already take account of additions required for terrain/obstacle clearance. Where this conflicts with other airspace reservations, it is incumbent upon ATC to offer either a crossing clearance or a re-route around the airspace.

7.3 **Avoiding Airspace Reservations.** As with terrain clearance, pilots intending to overfly airspace reservations should be cognisant of the potential impact of pressure variance within an ASR. To enable safe overflight of airspace reservations (Danger Areas, Restricted Areas and Prohibited Areas), where the upper vertical limit is defined as AMSL, pilots should adopt one of the following procedures:

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[9] Airspace with defined vertical limits of FL185 will require amendment for clarity as FL185 and FL190 will only be available tactically and will not be available for flight planning purposes.
[10] An adjacent aerodrome is considered to be one within 50nm of the aircraft.

a. When utilising an ASR QNH pilots should always add at least 200ft to the depicted upper limit of the airspace reservation. When the ASR QNH bulletin contains a pressure warning (see para 5.6) of ≥ 6hPa pressure gradient across an ASR, an additional 300ft should be added, making a total of at least 500ft to cater for the most significant cases of variance.

b. When flying on an aerodrome QNH, provided the airspace reservation is within 25nm of the aerodrome, a pilot may overfly the airspace reservation without the need to make allowance for any difference in pressure between the two sites.

c. When flying on an aerodrome QNH where the airspace feature is between 25nm and 40nm from the aerodrome, the pilot should add 100ft to the depicted top level (AMSL), of the airspace reservation to ensure against inadvertent infringement.

d. When operating beyond 40nm from the source aerodrome, pilots should either obtain an aerodrome QNH from a closer aerodrome, or should utilise the ASR QNH.

Where the addition of extra altitude conflicts with airspace reservations above, pilots must either request a crossing clearance or re-route around the airspace reservation. When in receipt of an ATS where altitudes have been allocated, levels offered by ATC will already have taken account of this additional data in order to avoid infringing airspace reservations. Likewise, where this action conflicts with other airspace reservations, it is incumbent on ATC providers to offer either a crossing clearance or a re-route around the airspace reservation. 'Floating' airspace reservations[11] beneath the TA will be defined by the ASR QNH; consequently, flights operating on the ASR QNH will not be required to add or subtract height to their selected cruising altitude in order to avoid airspace infringement.

7.4 Information on altimeter setting procedures is given at UK AIP ENR 1.7. However, the level at which a flight is to be conducted is to be specified in a flight plan as follows:

a. Above the TA as a Flight Level.

b. At or below the TA as an Altitude.

Departure

7.5 The relevant aerodrome pressure (QNH or QFE) will be passed to pilots prior to departure. At UK aerodromes the designated location for pre-flight altimeter checks is the apron and the threshold elevation of civil and some military UK instrument runways are contained within the UK AIP. When remaining in the visual circuit or radar pattern, aerodrome QNH or QFE shall be used as appropriate. However, an ATZ that shares both

[11] A floating airspace reservation is one where the lowest level of the airspace is a figure above MSL.

CAS and Class G airspace (e.g. Denham or Fairoaks) should utilise an appropriate pressure dependent upon the requirements of the flight as promulgated for that airspace.

In Transit

7.6 Pilots in receipt of an ATS should expect the Air Traffic Controller/Flight Information Services Officer (FISO) to provide and update the ASR QNH or aerodrome QNH/QFE as appropriate. When operating an aircraft below the TA, pilots will maintain altitude by reference to an altimeter as follows:

a. The current reported ASR QNH along the route of flight; or

b. The current reported QNH of an appropriate available aerodrome; or

c. In aircraft without a radio, the elevation of the departure aerodrome and an appropriate QNH setting available en route before departure.

7.7 Pilots not in receipt of an ATS who conduct their flight solely based upon an aerodrome QNH or QFE should note the guidance at paragraphs 7.3 b to d. Research undertaken by the TAPT has determined that, within 50nm of the source aerodrome, Met Office data indicates that atmospheric pressure variance is ≤ 3hPa for 98.7% of the time and ≤ 4hPa for 99.85% of the time; 3 hPa being equivalent to 82 ft and 4 hPa being equivalent to 109 ft. Beyond 50nm from the observed source, atmospheric pressure variance increases exponentially and additional calculations must be applied to ensure that required terrain clearance criteria are achieved. This atmospheric pressure variance can have a significant effect upon the vertical position of an aircraft above the ground and thus a pilot's ability to avoid airspace infringement.

7.8 Pilots should be aware of the challenges posed in avoiding airspace infringement when utilising an altimeter setting which differs to that which defines the airspace reservation. Pilots not in receipt of an ATS are encouraged to obtain an updated altimeter setting value. Pilots flying in compliance with the semi-circular rule should be aware of the altitude differences that could be experienced at ASR or FIR boundaries when adjusting to the next ASR QNH value.

7.9 Variance of pressure within individual ASRs and variance of pressure between NASAS are depicted at Annex C and D respectively.

Approach and Landing

7.10 The aerodrome QNH or QFE should be set prior to landing or as directed by ATC. In the event of a missed approach or when operating within the radar pattern, pilots shall continue to use the aerodrome pressure in lieu of the ASR QNH if the intention is to make another approach to the same aerodrome. When requested by pilots or where local procedures require, the appropriate aerodrome or threshold elevation shall also be given.

8 GENERAL CONTROLLER OPERATING PROCEDURES

8.1 Depending on the type of ATS provided, it is incumbent upon controllers to manage the pressure values used by aircraft in receipt of an ATS. This is to ensure that flights are operating on an appropriate pressure datum and that any conflicting aircraft on varying altimeter setting data remain separated or deconflicted. Procedures will be developed and agreed between units to ensure that when an aircraft is transferred and a change in QNH is required, it does not engineer a loss of separation. Where a control unit operates across multiple ASRs, full account must be taken of the potential pressure differences between each ASR to ensure retaining standard separation or deconfliction as necessary at all times.

8.2 When utilising an ASR QNH for the purposes of altitude allocation, ATC shall add at least 200ft to any terrain clearance calculation that is based on AMSL, or to the depicted upper limit of any airspace reservation where the vertical limit is defined as AMSL. When the ASR QNH bulletin contains a pressure warning (see para 5.6) of ≥ 6hPa pressure gradient across a an ASR, an additional 300ft shall be added making a total of at least 500ft to cater for the most significant cases of variance. Where this action conflicts with other airspace reservations, it is incumbent on ATC providers to offer either a crossing clearance or a re-route around the airspace reservation.

8.3 When utilising an aerodrome QNH/QFE, terrain and obstacle clearance are achieved through the allocation of levels by ATC that are in accordance with the information published on the Surveillance Minimum Altitude Chart (SMAC), or through a procedure approved by either the CAA or MOD as appropriate. When an airfield ATC provider issues a level based on an aerodrome QNH for the purpose of overflight of an adjacent airspace reservation, there is the potential for minor pressure differentials between the two. Where the pressure datum defining the airspace reservation is known, it should be utilised in order to calculate the correct minimum level to overfly the reservation. Alternatively, where the pressure datum is not available, provided the airspace reservation is within 25nm of the aerodrome, the airfield ATC provider may issue a level to overfly the reservation without the need to make allowance for any difference in pressure. Where the airspace reservation is between 25nm and 40nm from the aerodrome, ATC providers should add 100ft to the depicted upper limit (AMSL) of such reservations to ensure against inadvertent infringement. Beyond 40nm from the aerodrome, ATS providers should utilise the procedure based on the ASR QNH for the overflight or underflight of airspace reservations. For portions of CAS or floating Danger Areas whose dimensions are defined by the ASR value in which they lie, direct comparison between aerodrome QNH and ASR value is required.

8.4 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[12] are used, the aircraft's MODE C readout could appear to 'jump' or 'drop'. Similar events, depending on

[12] A surveillance QNH conversion area is an area defined by an ANSP within its 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.

the datum selected on radar display at civilian and military units and pressure differentials, may occur as aircraft cross ASR and FIR boundaries.

8.5 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[13] at the processing boundary and ‘creeps’ of the displayed SSR pressure altitude as the aircraft adjusts to recapture the altitude.

8.6 At and below the TA, unit surveillance systems may display SSR pressure altitude reports in relation to the corresponding ASR value, the aerodrome QNH or the Standard Pressure Setting of 1013.2hPa. Where aircraft below the TA operate on a pressure other than the QNH datum that is set within the Unit’s surveillance system, the displayed altitude data may be at variance to the stated or cleared altitude[14]. Unit procedures and training will be required to ensure that the display of SSR pressure altitude reporting information does not adversely affect the safe provision of ATS.

8.7 Where verbal, electronic or standing agreement co-ordination (including the use of Radar Corridors or Cleared Flight Path procedures) has been effected between controllers or ANSPs for the purpose of achieving required vertical separation or de-confliction minima based on the same altimeter setting, the following shall apply:

a. Co-ordination based on standing agreements or electronic methods, the pressure datum to be used shall be specified.

b. Verbal co-ordination agreements, the name and value of the pressure datum shall be specified. [15]

R/T Phraseology

8.8 The principles for R/T phraseology are to be in accordance with the requirements of CAP 413. A QNH value shall be given to a pilot:

a. On clearance from a Flight Level to an Altitude.

b. On changing ASR region at an altitude when the QNH value is different.

c. Upon re-clearance of an aircraft to an altitude from an initial clearance to a Flight Level.

8.9 The general principles for aircraft operating within the same ASR when a new METAR becomes available are:

a. En route sectors in London/Scottish to pass as soon as is operationally practicable.

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[13] This term replaces SSR Mode C.
[14] Surveillance equipped ANSPs will be required to provide safety assurance.
[15] Where shared QNH data is available, amendments to these procedures may be permissible. This could allow for either the name of the pressure value or numerical value being used, but not necessarily both.

b. Approach sectors would operate in accordance with current principles.

c. Broadcast QNH may be used by ANSPs where all aircraft on the frequency in use are required to set the same pressure value on their altimeter sub-scale, subject to suitable safety assurances being in place. The procedures are to be detailed in local instructions.

9 ATC STANDARD OPERATING PROCEDURES

Routine Procedures

9.1 Aerodromes will normally utilise the Aerodrome QNH after departure. However, changing the QNH of an aircraft flying a Standard Instrument Departure (SID) does not cancel the pilot's responsibility to follow the vertical profile of the SID based on the updated pressure. This applies whether the change is due to an Aerodrome QNH being updated or an ASR QNH being applied. It is the controller's responsibility to ensure that traffic remains separated and within the vertical protection of CAS. It is the responsibility of the releasing ATC unit to transition the aircraft to the ASR QNH prior to transferring the aircraft to the next ATC agency, unless in accordance with MATS Part 2 or tactical coordination and transfer agreements. There is no requirement for the controller to advise a pilot to report the QNH to the next agency.

QNH Tolerance

9.2 A raised TA generates challenges in the maintenance of an absolute 1000ft separation between interacting airport departures and arrivals operating on disparate aerodrome QNH, and interactions between these and aircraft cruising on the ASR QNH. It has been recognised that, for certain specific procedure and aircraft interactions, there may be a need to tolerate the constrained application of a variance between aircraft altimeter settings under specific circumstances. Whilst aircraft would continue to be assigned altitudes separated by 1000ft, the application of such a 'QNH tolerance' would lead to a nominal Vertical Separation Minima (VSM)[16]. This concept has been subjected to extensive safety assurance (see paragraph 9.6).

9.3 The CONOPs has been developed on the principle that the maximum altimeter setting variance that will be tolerated between two aircraft should not exceed 4hPa but shall not exceed 5hPa. It will be the responsibility of the ANSP to define the exact means of delivering the use of QNH tolerance; however, one method of operation that has been identified is to devise a procedure whereby the altimeter settings of participating flights will be managed such that they remain within 2hPa of the specified altimeter setting datum[17]. The following scenarios are currently considered to be potential candidates for the use of such a procedure, subject to the ANSP proving a demonstrable need and providing appropriate safety assurance:

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[16] MATS Part 1 Edition 6 Section 1, Chapter 3, Paragraph 5, Vertical Separation

[17] A conceptual safety argument in support of this method of operation has been developed and will be subject to subsequent CAA regulatory approval.

a. Interaction of departure and arrival procedures from/to multiple aerodromes, which require the specific aerodrome QNH to be set.

b. Interaction of aircraft cruising on an ASR QNH with aircraft operating on specific aerodrome QNH whilst flying arrival and departure procedures.

c. At UK ASR or at international boundary interfaces with adjacent ANSPs.

9.4 **Aircraft Formations.** For formation flights within controlled airspace, all aircraft within a formation shall be flown at 'a distance not exceeding 30m (100ft) vertically from the flight leader' (SERA.3135). Except for those procedures related to the issuance of an updated altimeter setting (see paragraph 9.5 below), no additional QNH tolerance shall be applied between two or more aircraft formations. With regards to the coordination of an individual flight with an aircraft formation, the QNH tolerance value applied by an ANSP should not exceed 2hPa but shall not exceed 3hPa; no additional QNH tolerance may be applied. This reduced QNH tolerance value relates to the fact that each of the formation might be separated from the formation leader by up to 100ft vertically.

9.5 **Altimeter Setting Update Procedure.** The increased volume of airspace in which altitudes will apply required the development of a procedure to manage the altimeter settings of coordinated flights, where two aircraft are vertically separated by an absolute[18] 1000ft but need to be transitioned to an updated altimeter setting value. The following principles shall apply:

a. The aircraft subject to the coordination agreement must be vertically separated by an absolute minimum of 1000ft and be operating on the same altimeter setting datum and remain so during the period of validity of the coordination agreement, prior to any change in aircraft altimeter setting being instructed.

b. Provided the change in altimeter setting is no greater than 2hPa, controllers may instruct aircraft in receipt of a service to change to that new setting without further coordination taking place. Stipulating a value of 2hPa ensures that:

(i) there would be no adverse effects on TCAS;

(ii) it is likely to encompass a significant majority of pressure events; and complements the proposed delivery mechanism for QNH tolerance of ± 2hPa.

c. The use of an altimeter setting variance associated with this procedure must be contained within the maximum altimeter setting variance which should not exceed 4hPa and shall not exceed 5hPa.

9.6 **Safety Assurance.** In accordance with normal safety assurance and oversight processes, other than for those circumstances defined in paragraph 9.5, it will be the responsibility of the ANSP to seek approval from their respective regulatory authority to provide nominal VSM through the application of a QNH tolerance. In doing so, ANSPs will

[18] An absolute VSM is defined as the separation of 2 aircraft by 1000ft with both aircraft being operated on the same altimeter subscale setting, or, the separation of 2 aircraft by 1000ft, correcting for a variance in altimeter subscale settings using the operational assumption of 1 hPa equating to 30 ft.

be required to demonstrate, within a safety case, an acceptably safe means of delivering the concept. Core principles that ANSPs must consider in determining whether or not to seek approval for the provision of a nominal VSM are that:

a. An absolute VSM shall always be aspired to. However, where it is identified that safety, workload, or other factors, necessitate the provision of a nominal VSM, then ANSPs may seek approval to utilise a QNH tolerance in mitigation. Where such mitigation is applied, a return to an absolute VSM should be applied as soon as practicable.

b. All civilian and military aircraft must be integrated without restriction. Procedures should be devised that deliver the concept, wherever possible, without reliance on equipment based controller support tools that rely on Enhanced Mode S aircraft and associated ATC equipment capability.

c. The concept should be limited to airspace with surveillance provision and with a density and controller workload such that any variation that exceeds the normal SSR pressure altitude reporting tolerance can be appropriately identified by the ATCO, with corrective action able to be provided in a timely manner.

9.7 The UK State TA Project has developed a conceptual safety argument for nominal VSM, which it is anticipated will be adopted by the CAA[19] and MAA. There will be no requirement to duplicate or replicate any of this work within an individual ANSP's safety case. The safety case submitted by an ANSP shall, as a minimum, satisfy the following requirements:

a. Demonstrate that safety, workload, or other factors necessitate the use of a QNH tolerance. This may be in the form of documented workload assessments or hazard analysis and should provide a rationale for the selection of a QNH tolerance concept over alternative mitigations and a clear scope of use for the concept, including how the concept will be applied and will be time-bound in its application.

b. Demonstrates that the concept will ensure safe and appropriate interactions with other ATC providers and for all airspace users.

c. Where an ANSP determines that an exceptional requirement exists to utilise the maximum QNH tolerance value of 5hPa, ANSPs should clearly articulate the justification for its use and the additional measures required to mitigate any increase in TCAS events.

d. Demonstrate how the 2hPa altimeter setting variance associated with the procedure to manage altimeter setting updates will be contained within the overall use of a QNH tolerance whose combined maximum value should not exceed 4hPa but shall not exceed 5hPa.

e. Address and mitigate the risks associated with ATCO human factors which include but are not limited to the effects of:

[19] The CAA will present this within a CAA Policy Statement on nominal VSM which will be published in mid-2016.

(i) an increase in TCAS RA Events.

(ii) an increase in STCA Events.

(iii) the visual perception of nominal VSM on a surveillance display.

(iv) increased workload associated with altimetry calculations.

f. Explain fall-back procedures for use when ASRs are subject to significant weather fronts such that an 'out of tolerance' QNH gradient[20] exists between the ASR QNH and the aerodrome QNH of surrounding aerodromes.

g. Address, where applicable, the integration of formation flights, whose elements may operate at a distance not exceeding 100ft vertically from the formation leader, with other traffic in a nominal VSM environment.

h. Demonstrate how the ANSP's SMS will identify those incidents attributable to the use of a QNH tolerance.

i. Where there is reliance on such equipment, address issues regarding the operation of aircraft with failed Mode S transponders.

9.8 **Nominal Airspace Containment.** A raised TA will increase the volume of CAS where the base is defined as an altitude and thus be affected by atmospheric pressure variance. Consequently, potential wider applications beyond aircraft separation have been identified for the use of a QNH tolerance; specifically that:

a. Where the base of CAS is defined as an altitude, the maintenance of an absolute 500ft above the base becomes unachievable due to the inevitable delay between a promulgated update in the published pressure datum and an adjustment in the aircraft's altimeter setting.

b. Legacy ANSP procedures and airspace designs mean that for some flights within CAS beneath the TA, the minimum level allocated by ATC, or the level directed on a SID/STAR, is based upon the aerodrome QNH, whilst the base of CAS may be defined by an alternative adjacent aerodrome QNH. Therefore, when the aerodrome's QNH varies from the 'area' QNH, the aircraft may have less than 500ft vertical separation above the base of CAS. Such arrangements have the potential to be formalised based on a defined policy.

9.9 It is intended that the CAA will pursue the development of a nominal airspace containment policy for future airspace and instrument flight procedure design; such development should also facilitate the continued approval of legacy arrangements. It is also intended that the CAA will provide ANSPs with guidance on the need for an ANSP, as part of TA implementation activity, to assess any change in legacy nominal airspace containment generated by any potential new use of an ASR QNH, and/or from the base of CAS being defined as an altitude instead of a flight level.

[20] A QNH Gradient refers to a stepped change in atmospheric pressure caused either by a weather front moving across an area, or by the difference in atmospheric pressure between a point at a distance from the pressure datum; for example the distance between EGSS and EGLL, the NASAS for the proposed London ASR.

ASR Boundaries and Use of FL190

9.10 Unit procedures shall be defined to ensure that aircraft are provided with the ASR QNH for the region it is about to, or has just entered, taking account of sector and ASR boundaries. Unit procedures are to be promulgated to ensure that aircraft remain appropriately separated in the vicinity of the ASR boundary, either whilst remaining under the control of a sector operating across multiple ASRs, or during transfer to another sector with coincident ASR boundaries. If it is anticipated that an aircraft leaving CAS will be operating below the TA, the Controller should ensure that the aircraft has an appropriate pressure value.

9.11 Tactical use of FL190 would be permissible provided the ASR pressure is 1014hPa or above, in accordance with local procedures or restrictions.

ATC Coordination with Adjacent ANSPs

9.12 All existing Memoranda of Understanding and Letters of Agreement will need to be reviewed and updated as necessary. In particular, those that currently utilise FL190 and FL200 will require reviewing by ANSPs.

9.13 Where bi-directional routes and areas of ATS delegation are involved there is likely to be a more significant impact (e.g. use of laterally spaced routes and level allocation etc). These issues will be the subject of future bi-lateral discussions between the Air Traffic Service Units (ATSUs). Proposed changes will need to accommodate subsequent TA changes by other States.

9.14 It should be noted that when the UK changes its TA to 18,000ft, and irrespective of whether neighbouring States change to the same TA at the same time, or in the future, there will be a need to mitigate the potentially significant QNH gradient between abutting ASR regions at the FIR boundary. Unit procedures are to be promulgated to ensure that aircraft remain appropriately separated in the vicinity of the FIR boundary.

9.15 The CAA defines the rules used by States operating within UK airspace however, areas of ATS delegation within UK airspace are still subject to discussion between affected parties.

Class G Airspace Operations

9.16 ASR QNH will be available for controllers for the provision of service within Class G airspace. However, units may decide to utilise a more suitable QNH such as the airfield QNH for the provision of service within the unit's area of coverage.

9.17 A Lowest Forecast Pressure (LFP) will be retained for military in-cockpit use to ensure obstacle clearance and to reduce the risk of controlled flight into terrain (CFIT) for autonomous flights within Class G airspace. The LFP regions will mirror the UK Low Flying Areas[21]but LFPs will not be promulgated for civil use or ATS provision.

9.18 In cases where a level has been agreed in coordination, it is the responsibility of the transferring unit to ensure that the aircraft has been instructed to set the agreed QNH prior to transferring the aircraft to the next agency. Additionally, where an airfield transfers an aircraft to an en route service provider, the aircraft should be instructed to select the relevant ASR value prior to transfer. There is no requirement for the controller to advise a pilot to report the QNH to the next agency; however, the pilot should check-in with the next agency stating the QNH value set.

9.19 Flights operating below the TA should be passed an appropriate altimeter setting on first contact following transfer from another unit/sector unless it is the intention to clear them immediately to a Flight Level or procedures exist which negate the requirement.

9.20 Where a controlling unit operates in airspace across multiple ASRs, unit procedures shall ensure that aircraft remain appropriately deconflicted at, and in the vicinity of the ASR boundary. When there is a pressure difference between adjacent ASRs, additional procedural measures may be required to ensure deconfliction minima are maintained where necessary.

9.21 Where Class G airspace is situated immediately below the DFL, when the pressure is low enough (959hPa or below)[22], ATCOs and FISOs are to be aware that pilots operating at the TA of 18,000ft would be infringing Class C airspace. Whilst it is the pilot's responsibility to remain clear of CAS, it is incumbent on controlling units providing a service to offer advice to prevent inadvertent CAS infringement; this low pressure will be notified through a Met Office warning.

10 MINISTRY OF DEFENCE (MOD) AND AUTONOMOUS RADAR UNIT INTERFACES

10.1 The CONOPs principles are that:

a. Military aerodromes may continue to use either QFE or QNH to define instrument procedures, radar patterns etc subject to the requirements of that aerodrome.[23].

b. ATSUs that operate radar corridors shall have procedures to ensure continued safe operations, balancing the needs of civil and MOD operations, as a seamless transition from Flight Level to Altitude for those established at or below 18,000ft. Corridors defined currently at FL190 shall be redefined at 17,000ft based on the ASR in which they lie.

c. A block of airspace will be established for air-to-air refuelling sorties operating above and below the TA, within which the tanker and the refuelling aircraft will

[21] MOD is in discussion with the Met Office.
[22] This is based on the ICAO values.
[23] As will some civil aerodromes.

operate on a common QNH regardless of their position in relation to the TA or ASR boundary.

d. Military formation flights within CAS will operate in accordance with Standardised European Rules of the Air (SERA) regulations, (i.e. ± 100ft from the leader's altitude). There will be no bar to formation flights operating within CAS as a result of QNH tolerance being applied.

ANNEX A: GLOSSARY

DEFINITIONS

Absolute VSM (Vertical Separation Minima)
The separation of 2 aircraft by 1000ft with both aircraft being operated on the same altimeter subscale setting, or, the separation of 2 aircraft by 1000ft, correcting for a variance in altimeter subscale settings using the operational assumption of 1hPa equating to 30ft.

Altimeter Setting Region (ASR) QNH
The altimeter setting to be used when operating in an ASR based upon the actual QNH derived from the 00:20 and 00:50 METARs.

Lowest Forecast Pressure (LFP)
Currently the UK Met Office calculates hourly the lowest forecast QNH[24].

METAR
Coded weather report for an aerodrome which includes QNH.

Nominal VSM
Where aircraft are assigned cruising altitudes separated by 1000ft but where the aircraft are operating with a variance of up to 4hPa 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.

NOMINATED ALTIMETER SETTING AERODROMES OR STATIONS (NASAS)
The aerodrome or station from which the ASR QNH will be derived and promulgated in the half-hourly METAR update.

Predicted QNH
Where a NASAS is unable to provide an ASR QNH the UK Met Office will provide a forecast QNH value.

Pressure Gradient
A pressure gradient is a change in atmospheric pressure between two points. This may be caused by a weather front moving across an area.

QFE
The barometric altimeter setting that will cause an altimeter to read zero when at the reference datum of a particular airfield (e.g. runway threshold). The altimeter will read height above the airfield datum.

QNH
The atmospheric pressure at an aerodrome corrected to mean sea level (based on the ICAO International Standard Atmosphere conditions throughout the height difference).

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[24] Work is required to determine if 3hPa is still required to be subtracted from the lowest forecast pressure before promulgation.

Radar Approach
An approach in which the final approach phase is executed under the direction of a controller using radar.

Surveillance QNH Conversion Area
A surveillance QNH conversion area is an area defined by an ANSP within its 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.

Transition Altitude
The altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes.

Transition Level
The lowest flight level available for use above the transition altitude.

ASSUMPTION

As a general principle, 1hPa will be considered to be equivalent to 30ft for the purposes of calculating ATC coordination and separation requirements. It does not refer to any value programmed into ATS or aircraft systems.

MEANING OF WORDS

In the context of this document, the following words shall have the meanings as stated:

‘shall’, ‘is to’, ‘are to’ and ‘must’
mean that the instruction is mandatory

‘should’
means that it is strongly advisable that an instruction is carried out; it is recommended or discretionary. It is applied where the more positive ‘shall’ is unreasonable but nevertheless a pilot or controller would have to have good reason for not doing so.

‘may’
means that the instruction is permissive, optional or alternative, e.g. ‘a controller may seek assistance…’ but would not if he did not need it.

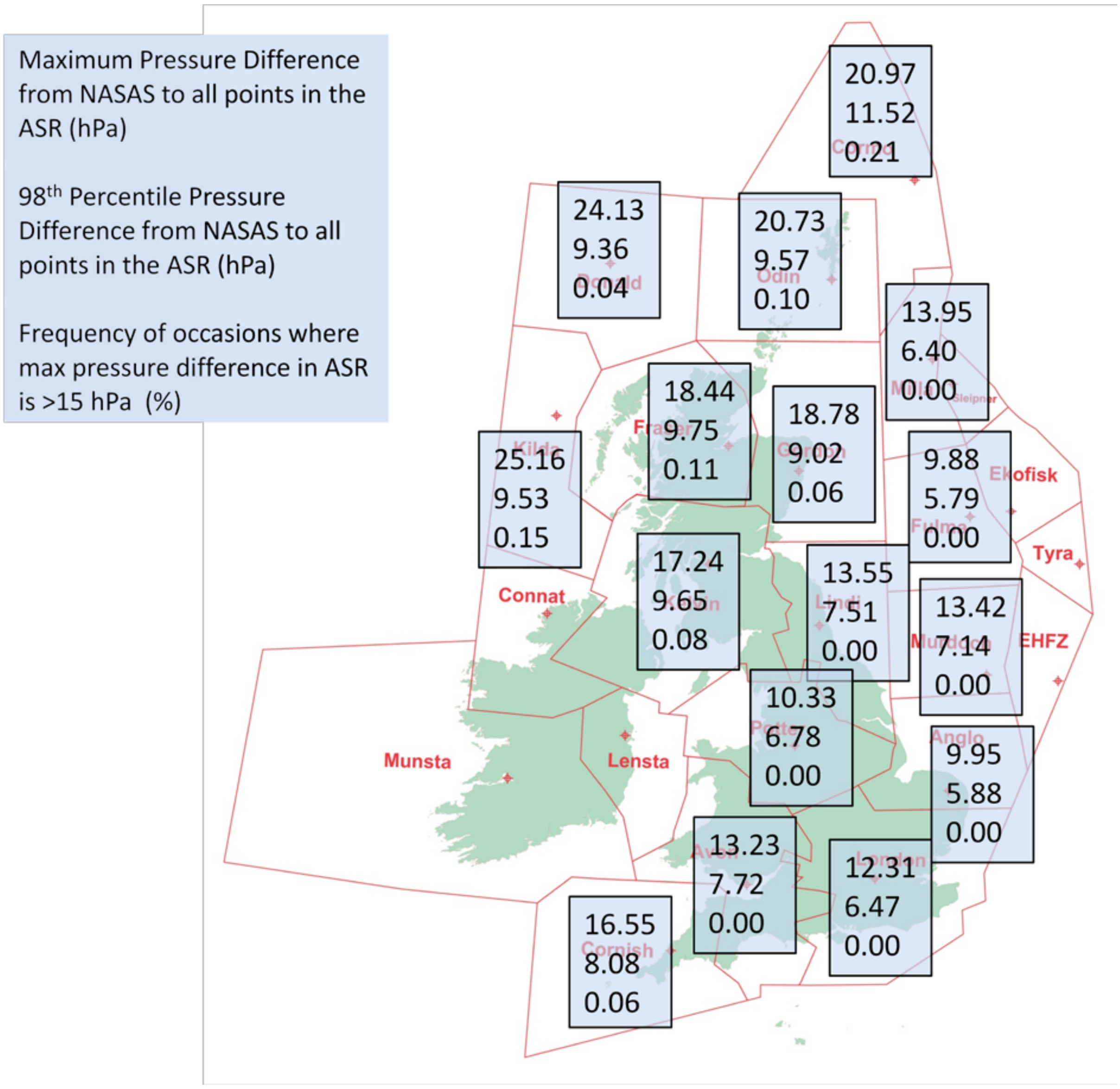
‘will’
is used for informative or descriptive writing, e.g. ‘pilots will file…’, is not an instruction to the pilot or controller.

ANNEX B: LIST OF NOMINATED ALTIMETER SETTING AERODROMES OR STATIONS AND CORRESPONDING ALTIMETER SETTING REGIONS

The following are the proposed NASAS within each ASR:

NASAS	ASR QNH Name
Cormorant Alpha (Rig)	Cormo
Predicted Value for Lat 60 N Long -7.5 W)	Donald
Sumburgh	Odin
Predicted Value for Lat 57.814N - 8.585 W)	Kilda
Inverness	Fraser
Aberdeen	Gordon
Miller (Rig)	Milla
Sleipner (Rig) (ATS delegated to Norway below FL85)	Sleipner
Ekofisk (Rig) (ATS delegated to Norway below FL85)	Ekofisk
Fulmar Alpha (Rig)	Fulma
Tyra Oest (Rig) (ATS delegated to Denmark below FL85)	Tyra
Donegal	Connat
Glasgow	Kelvin
Newcastle	Lindi
Murdoch (Rig)	Murdoch
F16 A (Rig) (ATS delegated to Netherlands below FL85)	EHFZ
Shannon	Munsta
Dublin	Lensta
Manchester	Potter
Norwich	Anglo
Newquay	Cornish
Cardiff	Avon
Heathrow	London

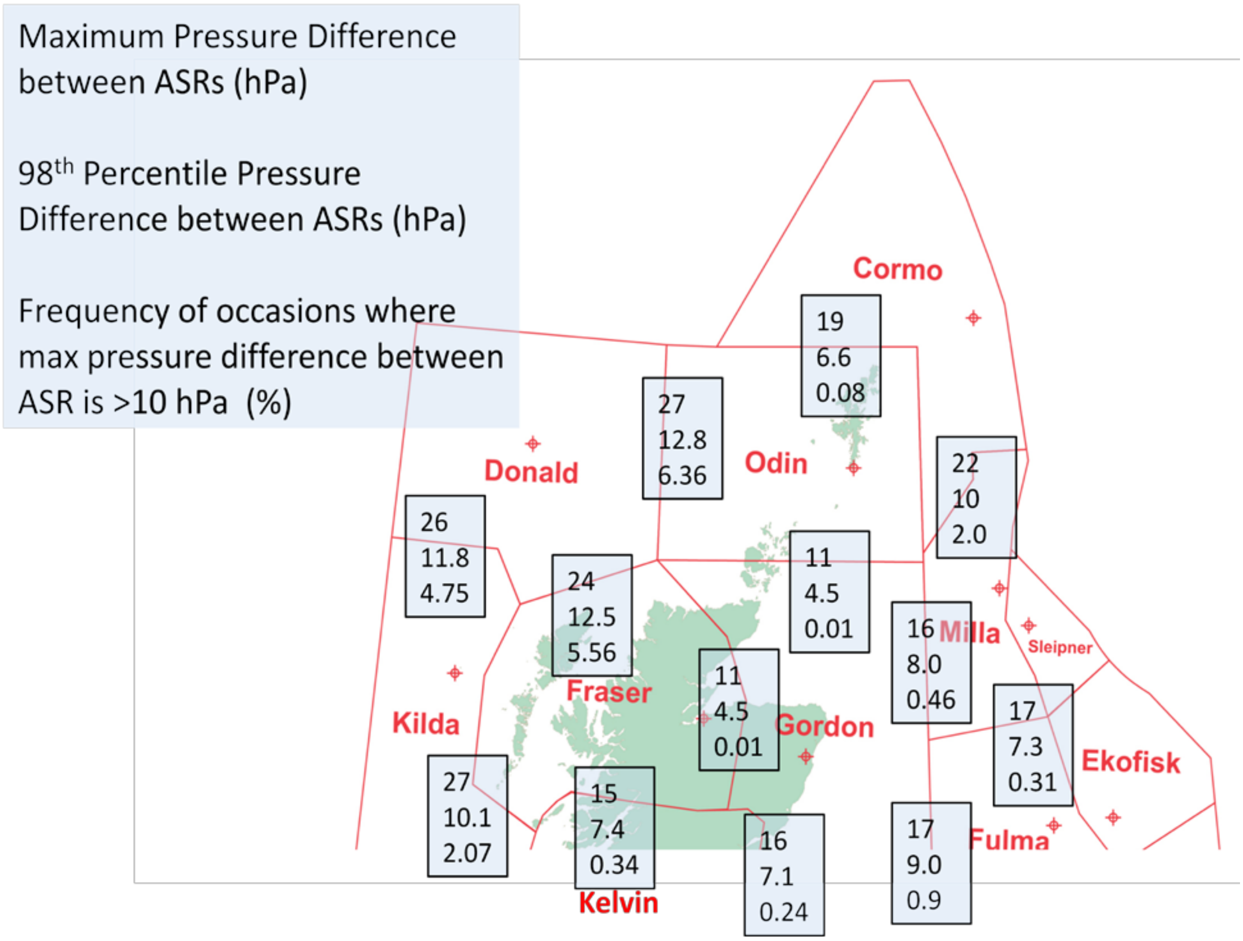
ANNEX C: VARIANCE OF PRESSURE WITHIN INDIVIDUAL ALTIMETER SETTING REGIONS



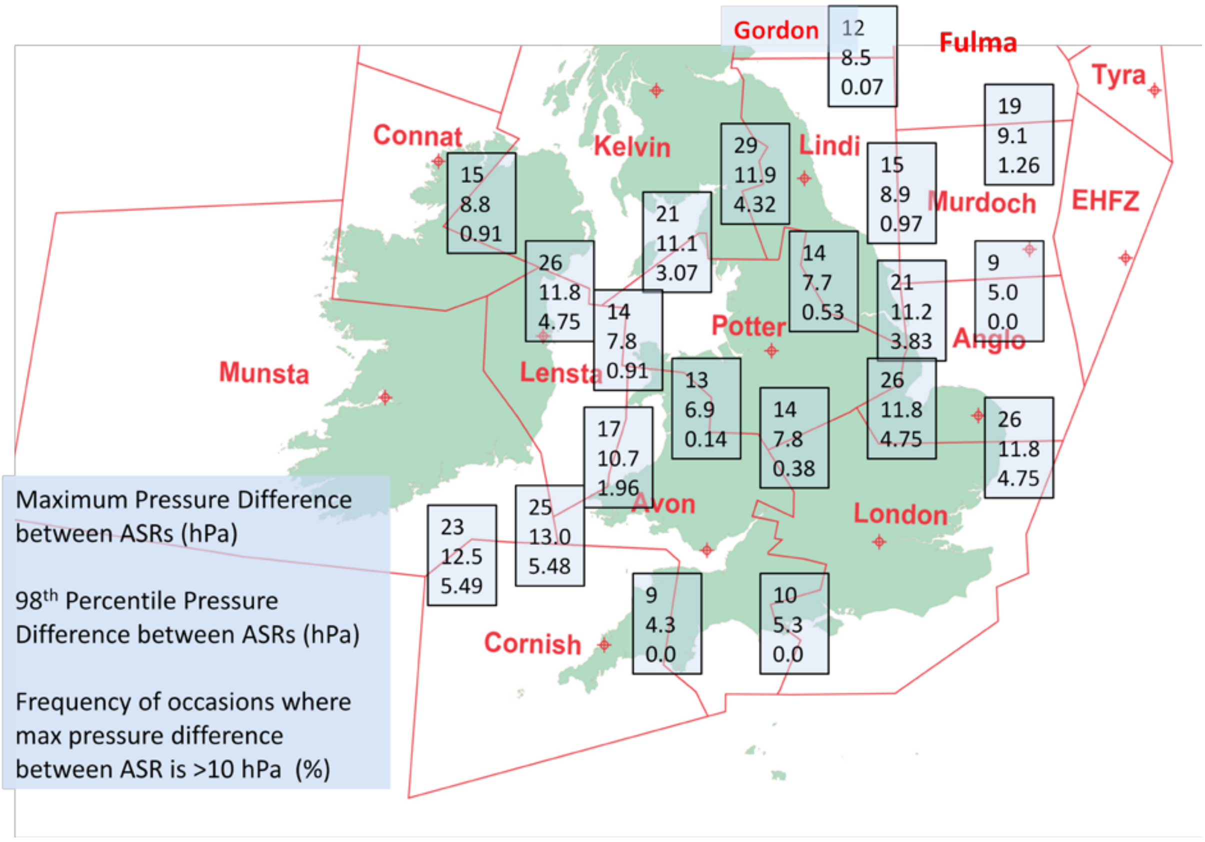
Data from the Met Office's North Atlantic & Europe limited area forecast model were extracted from the archive for the 5-year study period from October 2006 to September 2011 inclusive.

Met Office reference document: 'Variance of pressure within individual ASRs' dated 25th October 2013.

ANNEX D: VARIANCE OF PRESSURE BETWEEN NOMINATED ALTIMETER SETTING AERODROMES OR STATIONS



NORTHERN UK

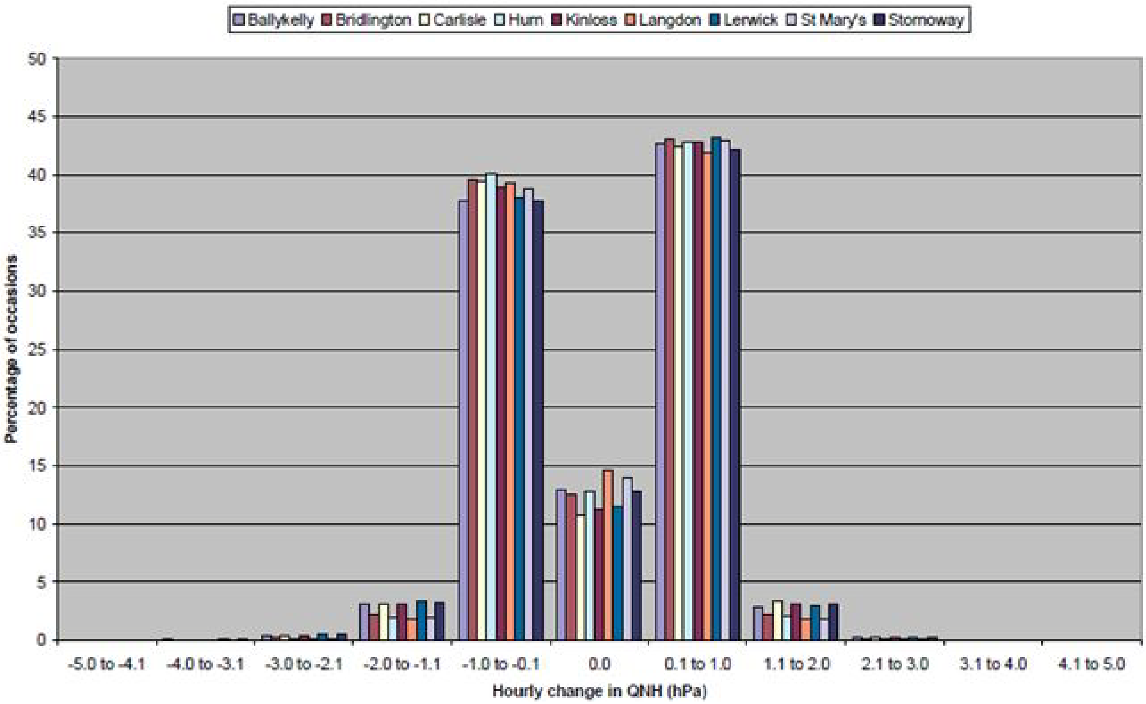


SOUTHERN UK

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.

Met office reference document: 'Variation of pressure between neighbouring ASRs' dated 28th January 2014.

ANNEX E: PRESSURE CHANGES AT MEAN SEA LEVEL



This graph shows the pressure variance of 9 sites across the UK, measured hourly. Over 90% of hourly changes in atmospheric pressure are with ±1hPa, irrespective of location within the UK. However, much larger hourly changes do occur, albeit with such low frequency they are not fully visible at the scale resolution.

Met Data taken from the stations listed from 2004 to 2010.