

Air Traffic Standards Department (ATSD) Consultation Document

Cold Temperature Corrections to Minimum Sector Altitudes (MSAs) and ATC Surveillance Minimum Altitude (ATCSMA) Chart Altitudes

Consultation period 3 February 2012 to 27 April 2012

1. Introduction

- 1.1 During the extreme cold weather experienced in the UK during winter 2011, an incident was reported to the CAA through one of the NATS Safety Partnership Agreement (SPA) meetings. The incident involved an arriving aircraft being vectored for an approach to runway 23R at Manchester International Airport in which the locally based pilots reported that their height above ground appeared to be lower than they would normally have observed. At the time of the incident the aircraft was in level flight at an indicated altitude of 3,500 feet and the reported aerodrome temperature was -15°C . At temperatures below International Standard Atmosphere (ISA) (i.e. $+15^{\circ}\text{C}$) the volume of air above the altimeter setting source becomes denser which causes the altimeter to over read.
- 1.2 International Civil Aviation Organization (ICAO) Doc 8168 PANS-OPS states that aircraft operators shall apply temperature corrections "...to all minimum altitudes..."¹. ICAO Doc 4444 PANS-ATM states "when necessary, the relevant minimum vectoring altitude shall include a correction for low temperature effect" and "it is the responsibility of the ATS authority to provide the controller with minimum altitudes corrected for temperature effect"².
- 1.3 During discussions with a number of UK aircraft operators it was highlighted that their operations manuals stated that Air Traffic Control (ATC) adjust the Minimum Sector Altitudes (MSA) during periods of cold temperature. However, the UK CAA does not specify such a requirement and there are no known UK ATC providers that have a procedure to correct published MSAs for cold temperatures. UK MSAs have a design temperature of ISA (i.e. $+15\text{C}$) and ATC do not apply a cold temperature correction.
- 1.4 ICAO Doc 8168 PAN-OPS provides two methods of determining a suitable correction. These are:
 - a) An approximate correction that involves a basic mathematic formula to add a correction of 4% of height for every 10°C below ISA, which "...is safe for all altimeter source altitudes for temperatures above -15°C "³; or
 - b) Tabulated data is based on maximum theoretical values that reflect the variations of lapse rates, which provides greater accuracy. However, the table does not provide correction data for temperatures above 0°C and for altitudes greater than 5,000 feet.

¹ ICAO PANS-OPS Volume 1, Section 4, Chapter 1, Paragraph 1.7.5

² ICAO PANS-ATM 8.6.5.2

³ ICAO PANS-OPS Volume 1, Section 4, Chapter 4, Paragraph 4.3.1

1.5 The tabulated data provided by ICAO in PANS-OPS⁴ is replicated in the UK AIP AD 1-1-8, seen below:

Aerodrome	Altitude Above Altimeter Source Elevation (ft) (normally destination elevation)													
	Temp °C	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000
0°	20	20	30	30	40	40	50	50	60	90	120	170	230	280
-10°	20	30	40	50	60	70	80	90	100	150	200	290	390	490
-20°	30	50	60	70	90	100	120	130	140	210	280	420	570	710
-30°	40	60	80	100	120	140	150	170	190	280	380	570	760	950
-40°	50	80	100	120	150	170	190	220	240	360	480	720	970	1210
-50°	60	90	120	150	180	210	240	270	300	450	590	890	1190	1500

Values to be added to published altitudes (ft)

1.6 Tabulated data in ICAO Doc 8168 and the UK AIP is commonly used by pilots to correct “...all minimum altitudes”, which includes ‘procedure altitudes’ such as those commonly referred to as ‘platform’ altitudes.

2. Scope

2.1 The contents of this consultation paper cover discussion and background material together with a number of CAA policy options with initial recommended/non-recommended status. The material has been developed by specialists within the CAA’s Safety Regulation Group (SRG) Aerodrome and Air Traffic Standards Division (AATSD), Flight Operations Division (FOD) and Directorate of Airspace Policy (DAP). The aim of this consultation is to gather industry comment which will allow the CAA to develop and promulgate appropriate new policy and procedures to be adopted by ATC providers on how to deal with MSAs during cold temperatures.

3. Actions in Other States

3.1 Within the European region there is not a common approach to this issue. In France, MSAs are corrected using a simple and practical solution that uses a table in which greater MSA values are used as the temperature falls within a band of temperatures. Switzerland employs a system where MSAs are corrected, but rather than correcting the MSA directly, the correction is applied to the QNH, thereby the QNH given to the pilot is lower than the actual QNH and the difference increases as temperature reduces. Whilst the specific detail is not known, aircraft altimeters have a limiting range of pressures that can be set in the subscale and it is unknown how corrections are applied if the corrected QNH is lower than the lowest pressure that can be selected by the pilot. In the Czech Republic, between the months of November to March, a standard 200 ft is added to all MSAs. In Norway, all MSAs use a design temperature of ISA -15°C rather than ISA.

3.2 In other regions of the world, cold temperature corrections are applied using different techniques to that of Europe. For example, in Canada the minimum radar vectoring altitudes are published using a cold design temperature. In the United States of America, the Federal Aviation Administration (FAA) does not currently require MSA adjustment by ATC.

⁴ ICAO PANS-OPS Volume 1, Section 4, Chapter 4, Paragraph 4.3.2

- 3.3 Eurocontrol SKYbrary guidance describes the error as being “...approximately “4 ft/1,000 ft per °C of difference” which is the same approximate mathematical guidance given by ICAO, but unlike ICAO, Eurocontrol’s guidance does not caveat the mathematical formula as being safe only above -15°C. However, Eurocontrol’s guidance gives very clear instruction with regard to MSAs and states: “When the temperature is -30°C or colder, add 1,000 ft to the MSA, to ensure obstacle clearance”.
- 3.4 Whilst Eurocontrol’s guidance clearly describes the relationship between temperature and height above the altimeter setting source, their MSA guidance to add 1,000 ft to the MSA when the temperature is -30°C or colder is too simplistic. Significant altimeter errors can be present at aerodromes with proximate high ground at temperatures well above -30°C.

4. Discussion and Options

- 4.1 In the UK, ATC Surveillance Minimum Altitude Charts (SMAC) used by Air Traffic Controllers to vector aircraft and UK Instrument Approach (IAP) charts which publish MSAs are designed using the ISA. The focus of this discussion is the design temperature of these charts and how low temperatures affect the terrain clearance ATC provides when using the information published on these charts.
- 4.2 From an ATC perspective, both SMACs and MSAs published on an IAP chart are intended to provide 1,000 ft terrain clearance, which occurs when the temperature is equal to or hotter than ISA (This clearance will reduce when aircraft are on final approach). The reason for this phenomenon is two-fold. Firstly, aircraft altimeters are calibrated to ISA and whilst an altimeter has a sub-scale for selecting pressure there is no sub-scale for correcting temperature; therefore, with respect to temperature, altimeters are only accurate whenever the atmospheric conditions match ISA. Secondly, if the atmosphere is thought of as a column of air, the height of this column changes proportionately to the change in air temperature. If the air in that column is warmer than ISA, then the height of that column will be greater than under ISA conditions, but more importantly, if the temperature is cooler than ISA then the height of that column will be less than in ISA conditions. The result being that when the temperature of the air is hotter than ISA, the aircraft’s altimeter will under-read, but the more dangerous of the two scenarios is when the temperature is cooler than ISA, as the aircraft’s altimeter will over-read. Therefore, in the absence of any temperature correction procedures applied by ATC, when a controller instructs a pilot to fly at MSA in temperatures colder than ISA, terrain clearance is potentially being compromised. However, it must also be remembered that the temperature at the position at which the aircraft is overflying could be at variance to the temperature at the source of the altimeter setting; therefore the error could be greater or smaller. Additionally, the theoretical error does not take account of potential temperature inversions at the source.
- 4.3 The approximate error is 4% of height above the altimeter setting source for every 10°C below ISA; and with regard to the incident at Manchester that initiated this study, the aircraft could have been between 380 ft (using ICAO’s/UK AIP tabulated data) and 386 ft lower than the altimeter was indicating (using ICAO’s approximate formula). If this was the case then a significant degradation of the terrain clearance may have occurred. It should be noted that this is a very conservative estimate.

4.4 The UK AIP ATC SMAC charts state the following:

“The minimum levels within the ATC Surveillance Minimum Altitude area ensure terrain clearance in conformity with Rule 33 of the Rules of the Air Regulations in respect of obstacles within the ATCSMAC area”.

Under conditions of extreme cold temperatures the published MSAs, if used, could lead to the terrain clearance being compromised. It should be remembered that the likelihood of this occurring is very rare and the actual error could be less than the theoretical value.

4.5 **Policy Options**

a) **Do Nothing**

Following discussions internally within the CAA, there is consensus that the current situation needs action as we now have an identified hazard with the possibility of a significant reduction in terrain clearance. There is also an expectation from elements of industry that a new procedure will be required as the subject has been discussed widely at the NATS SPA with aircraft operators. **Not recommended.**

b) **Apply a single national correction once the temperature reduces below a particular nationally set temperature**

Whilst this is a single standard solution, it is too simplistic, and in order to be safe it would need to be based on the worst scenario at the most limiting location. For example, some may argue that the point should be set at 0°C; however, whilst this may be tolerable risk in relation to some MSAs, where applied in relation to high MSAs, the error is likely to be intolerable. Therefore, in applying this correction nationally, it would be too restrictive and would reduce the volume of available airspace that can be used by ATC when the actual environmental conditions are better than the worst scenario. **Not recommended.**

c) **Apply a progressively increasing correction as the temperature reduces in one degree steps**

Whilst this method solves the issue ‘on paper’ and would be proportional to environmental conditions, this solution is impractical from an ATC perspective. An ATCO would need a table of temperature and altitude data specific to his location, which the ATCO would have to review and apply each time the temperature changed and was below ISA. Considering the number of MSAs and SMACs altitudes that would need individual correcting, the workload needed to facilitate this solution would be particularly excessive and unworkable in the majority of cases. **Not recommended.**

d) **Change the design criteria for SMAC and MSA to use a temperature other than ISA**

Currently all ATC SMACs are designed using ISA conditions. It might be possible to use the French approach by allowing unique design temperatures for each aerodrome based on historic temperature data or use a temperature, other than ISA, for all UK ATC SMAC design. This would cause a considerable amount of work to re-design all the UK ATC SMACs for surveillance operations and the procedural approach charts for non-surveillance operations. For the limited times the cold temperature hazard occurs this is not considered to be a practical option. **Not recommended.**

- e) **Introduce a local temperature correction that will apply appropriate corrections to MSAs and SMACs with increasingly cold temperatures and higher SMAC/MSAs.**

As the 'height' of the highest SMAC/MSA directly influences the degree of error, aerodromes with particularly high SMAC/MSAs would need to apply corrections at higher temperatures than those aerodromes with lower SMAC/MSAs. Therefore, action taken is proportionate to the degree of potential error. Use of a table similar to that shown in paragraph 1.5 but expanded for a complete set of temperatures below ISA and a wider range of altitudes would be required. There are 2 regulatory approaches proposed within this category as a means of implementation:

- i) Total risk-based approach. ATC providers are alerted to the effects and risk and assess the local impacts against the degree of error that is likely and adverse effects of making corrections. However, this situation may result in a lack of a common approach to the risk assessments and could prove challenging for regulatory oversight. Significant guidance to ANSPs would also be needed to explain how to determine and apply these corrections using a total risk-based approach. **Recommended for consideration.**
- ii) Balance of prescription versus risk-based approach. The CAA to prescribe a degree of error that must always be corrected, and allow ATC providers to apply risk assessment and local procedures to lower levels of error. This ensures that the greatest risk must be corrected, whilst allowing units to assess errors below this amount locally and to manage the risk locally balanced against other impacts. This solution would require the degree of intolerable error and risk based area to be specified by the CAA. It would also still require significant guidance material to be produced and a common approach to CAA review and acceptance of the risk assessments. This solution might be appropriate in areas where there is little chance of temperature and altitude variation within the lateral boundary of that particular MSA sector. **Recommended for consideration.**

5. Comments

5.1 **All interested parties are requested to read the content of this consultation paper and send comments to ATSD at SRG Gatwick using the details below. All comments are welcome on the material, particularly on the options provided.**

5.2 Comments and enquiries regarding this consultation should be sent to:

By post:

Air Traffic Standards Department
Safety Regulation Group
Civil Aviation Authority
2W Aviation House
Gatwick Airport South
Crawley
West Sussex
RH6 0YR

E-mail: ats.documents@caa.co.uk

2.4 Comments should be received by ATSD by 27 April 2012.