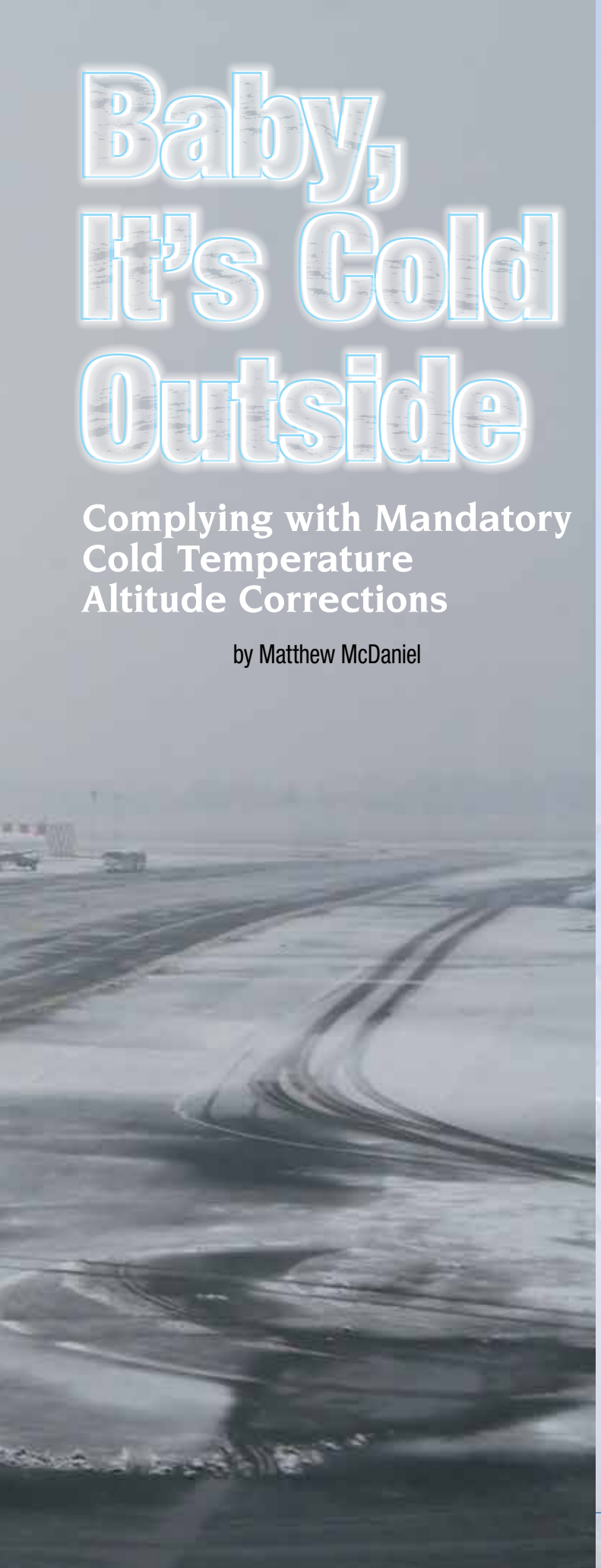
Baby, It's Cold Outside

Complying with Mandatory Cold Temperature Altitude Corrections

by Matthew McDaniel



The alarm jolts me awake at 4:30 a.m. and I fumble in the dark to stifle its intrusive wailing. Dreading the scene, I stumble to the hotel room window, pull the curtains, and confirm the accuracy of last night's forecast. Fresh snow blankets everything outside and gently falling snowflakes fill the beam of every street light. De-icing the aircraft is inevitable for this morning's 7:00 a.m. departure, but I know we'll still be going, and it's time to get a move on. Winter has arrived in Chicago and few airports are more adept at dealing with it than O'Hare International. Are you equally prepared for Old Man Winter and the FAA's new rules for dealing with him?

Flight Below Zero

Pilots who dare to venture into frigid skies, whether rarely or routinely, quickly learn that below freezing operations offer a unique set of challenges. Most cold weather precautions are common knowledge – pre-heating engines and avionics, respecting aircraft temperature limitations (upper and lower), inflight icing dangers, runway contamination and survival gear considerations, just to name a few. But, a far lesser known danger is cold weather induced instrumentation error. Extreme cold temperatures create significant altimetry errors, causing indicated altitude to read higher than actual altitude. In cruise flight, such errors are not a factor since all nearby aircraft should be experiencing the same level of error, eliminating any altitude separation concerns. However, left uncorrected, such errors can put an aircraft well below published minimum altitudes during Instrument Approach Procedures (IAP). During cold weather IAPs, barometric altimeters can leave pilots with a false sense of security by indicating they are at or above the applicable minimum altitude when, in reality, the aircraft is dangerously close to the ground or obstructions. As temperatures drop, safety margins begin to shrink. Eventually, the Required Obstacle Clearance (ROC) limits built into every IAP segment can be exceeded and altitude safety margins become razor thin or disappear altogether. Airports lying within mountainous terrain are particularly at risk, but since obstacle (not just terrain) clearance is a factor, even "flatland" airports can be affected.

Telluride, Colorado runway

Risk Assessment and Mandatory Compliance

Various influential aviation groups and safety organizations expressed concerns over altimetry errors in extreme cold temperature situations and the resulting erosion of ROC safety margins. In response, the FAA did a comprehensive assessment to determine if IAPs created and certified under FAR Part 97 were at risk. Part 97 IAPs are those within the U.S. National Airspace System and all comply with strict ROC limits. By using the coldest recorded temperatures over the last five years for each airport, the FAA investigated the probability and severity of altimetry errors during such extreme non-standard temperature operations. It was decided that airports with a one percent or greater probability of having temperature-induced ROC exceedances would have cold weather restrictions applied to any compromised approach segments. The result was more comprehensive guidance for pilots within both the Aeronautic Information Manual (AIM) and Notices to Airmen Publications (NTAP). Additionally, a list of specific Cold Temperature Restricted Airports (CTRA), where altitude corrections were recommended, was published in December 2014. The FAA deemed such corrections mandatory, effective September 17, 2015. The initial CTRA list included 272 individual airports in 30 states! Each IAP at CTRAs may be affected differently, in that the temperature thresholds may vary and mandatory corrections may apply to intermediate, final, and/or missed approach segments of individual IAPs. Airports may be added or removed from the CTRA list as assessments are expanded and revised. Such changes will be reflected in subsequent NTAP revisions.

Corrective information for extreme cold weather airports is nothing new. Correction tables and equations have been available from a variety of sources for years, but until recently, such information had been just that – *informational.* Additionally, pilots had to really want to educate themselves on such topics, as gathering the information could be a bit of a scavenger hunt. With the new rules ***requiring*** pilots to calculate and apply altitude corrections when operating at designated CTRAs, the

Cold Temperature Restricted Airport altitude correction example:

Approach: ILS or LOC 18 into LaCrosse, WI (KLSE) [Figure 1].

Temperature Threshold: Altitude correction required at/below -19°C/-2°F (note snowflake and temp notation on Figure 1).

Segments to be Corrected: While the original NTAP indicates which segment altitude(s) require correction, the IAP chart and A/FD do not. If you are unsure which segments are affected, applying correction to each segment to be flown is necessary to ensure compliance.

Interpolating: Interpolation of the ICAO Cold Temperature Error Table [Figure 2] is discouraged to prevent errors that might result in insufficient correction being applied. It is best to round to the next step (in the conservative direction) on the Error Table. Step to the next higher altitude difference and the next lower temperature. This will ensure you will always be at (or above) the required corrected altitude(s).

Assumed Current Temperature for this example: -25°C (-13°F).

Airport Elevation: 656 feet MSL

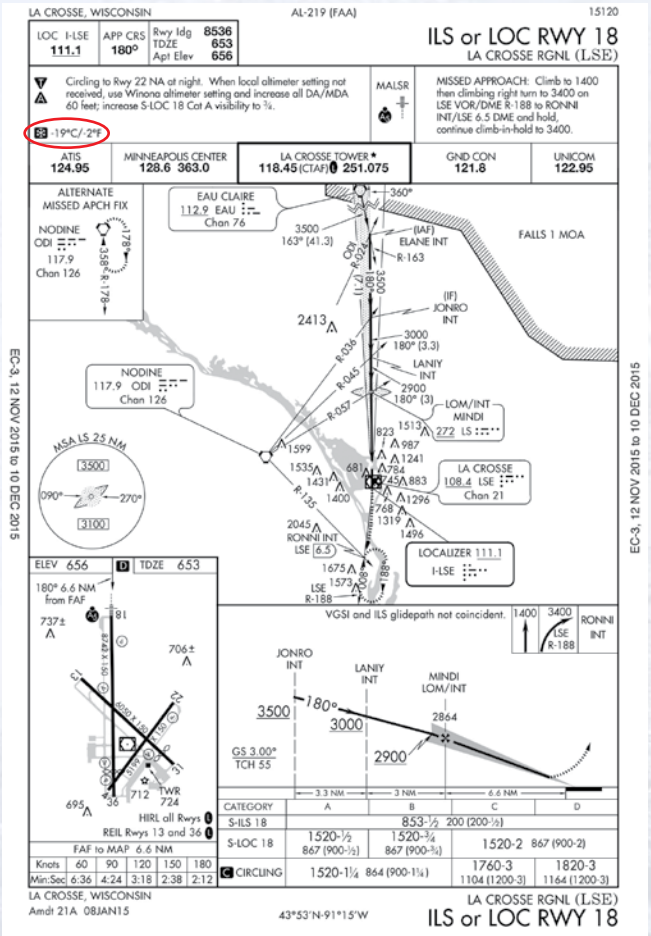


Figure 1: An example of the new notation on the Terminal Procedures Charts (Approach Plates) of all CTRAs – a white snowflake symbol over a black background.

TBL 7-2-3

ICAO Cold Temperature Error Table

Height Above Airport in Feet

Reported Temp °C	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
+10	10	10	10	10	20	20	20	20	20	30	40	60	80	90
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

EXAMPLE-

Temperature is -10 degrees Celsius, and the aircraft altitude is 1,000 feet above the airport elevation. The chart shows that the reported current altimeter setting may place the aircraft as much as 100 feet below the altitude indicated by the altimeter.

Figure 2: The ICAO Cold Temperature Error Table.

Assumed Flight Condition: Assume you are being radar vectored to intercept the inbound course between LANIY and MINDI intersections [Figure 1].

Correction Process: This intermediate segment's published minimum altitude is 2,900 feet MSL; 2,900 – 656 = 2,244 feet difference. So, enter the ICAO Cold Temperature Error Table at 3,000 feet (rounding to the conservative side). Drop down to the -30°C Reported Temperature line (again, rounding to the conservative side). Read the required correction of 570 feet. So, the new minimum altitude to be flown between LANIY and MINDI would be 2,900 + 570 = 3,470 feet MSL. Advise ATC you'd like to maintain 3,500 feet for cold temperature correction (rounding up to nearest 100 feet). Note, in this example, that may require intercepting the localizer further from MINDI (possibly even outside of LANIY) to ensure interception of the glideslope from below (which may also necessitate such a request of ATC).

Decision Altitude (DA) is published as 853 feet MSL. This is 197 feet above airport elevation and 200 feet above touchdown zone elevation. While airport elevation is the official reference, I would choose the higher of the two, to be conservative, as many touchdown zone elevations are higher than the average airport elevation. So, using 200 feet at -25°C (-30°C on Error Table) requires a 40-foot correction. Corrected DA is 893 feet MSL. Corrected DAs or MDAs need not be reported to ATC, as vertical traffic separation is not a factor at those altitudes and only the pilot can determine if in-flight visibility and appropriate visual references exist to allow continuation below corrected MDA/DA (refer to FAR 91.175).

The published Missed Approach Procedure (MAP) requires a climb to 1,400 feet MSL before turning and a final level-off altitude of 3,400 feet MSL; 1,400 – 656 = 744 feet (round to 800 feet on Error Table). Required correction is 150 feet. Thus, corrected initial climb altitude on the MAP should be 1,550 (round up to 1,600) feet MSL; 3,400 – 656 = 2,744 feet (round to 3,000 feet on Error Table). Required correction is 570 feet. Thus, corrected final MAP altitude is 3,970 (round up to 4,000) feet MSL. In the event of a missed approach (without ATC amendment), advise ATC you need to climb to at least 4,000 feet MSL for cold temperature altitude correction.

FAA has made the information not only readily available, but revisable, via AIM Chapter 7 and NTAP.

Compliance: Where, When, and How

Where: The initial list of FAA CTRAs issued in the December 2014 NTAP, was updated September 17, 2015. The NTAP is updated every 28 days and can be found within the *www.faa.gov* website. Space does not permit listing those airports here, but suffice it to say that while the majority are in northern states, many exist in locations one might not associate with extreme cold weather (California, Kansas and Tennessee, for instance). Wisely, the FAA chose to put a new notation on the Terminal Procedures Charts (Approach Plates) of all CTRAs; a white snowflake symbol over a black background [Figure 1]. The snowflakes began appearing on Approach Plates in the March 5, 2015 revision cycle and their implementation is an ongoing project, however, many current CTRA approach plates are still awaiting this addition. So, for now, check the NTAP and/or the Airport Remarks section of the Airport/Facility Directory (A/FD) to determine if your destination is on the CTRA list (and, if so, what temperature threshold applies).

When: Adjacent to the new snowflake symbol is the temperature where altitude corrections become mandatory. If multiple threshold temperatures apply at the same airport, the warmest one is published on all approach plates. When conducting that IAP, at or below the depicted temperature, pilots must make altitude corrections per the current NTAP. In lieu of knowing which specific segment(s) require correction (per the NTAP), pilots should correct all minimum altitudes on the IAP (i.e., err on the safe side, and fly corrected minimums for all segments of the IAP).

How: If there is not already, I'm sure there will soon be "an app for that!" However, unless that app is FAA approved (unlikely), pilots will have to make their altitude corrections via the FAA-approved "ICAO Cold Temperature Error Table" (AIM Table 7-2-3) [Figure 2]. This table is simple enough to use, but it does require familiarization and a bit of cross-referencing from the pilot. Most important, the reference numbers across the top are neither MSL, nor AGL altitudes. Rather, they are Height Above Airport (HAA) in feet. Thus, pilots need to cross-reference the official airport elevation (from any approved source) with the segment minimum altitude on the approach plate and calculate the difference. From there, drop down to the line corresponding to the current temperature to determine the required altitude correction. The sum of the correction factor and the minimum published altitude is the corrected altitude to be flown for the given segment, the Minimum Descent Altitude (MDA), the Decision Altitude (DA), and/or the missed approach altitude(s). Another way to think about the correction factor is that it is the number of feet below the indicated altitude the aircraft will be if flying uncorrected altitudes.

Playing Well with Others

ATC should be advised anytime an adjusted altitude is to be flown (other than MDA/DA altitudes). This ensures ATC knows when you've leveled off and what altitude you'll be maintaining, allowing known traffic to be safely separated. If being radar vectored, flying ATC-assigned altitudes, or flying an ATC-revised missed approach, pilots should fly the assigned altitudes (uncorrected). If being vectored to intercept an intermediate segment below the corrected minimum altitude, pilots should query ATC, asking to maintain the corrected minimum altitude (or above) for that segment. When flying IAPs into uncontrolled fields, self-announcements should include the corrected altitude being maintained. Pilots should keep their altimeters set to the local barometric pressure and ***not*** attempt to make altitude corrections by adjusting altimeter settings, in order to ensure ATC's ability to guarantee vertical separation minimums between aircraft. [See sidebar for a CTRA IAP example, with corrections applied.]

King Air Avionics and Cold Weather Altitude Corrections

As you might expect, the variety of avionics packages available in decades of King Air production and via retrofit is extensive, to say the least. It would be impossible to list how each package deals with cold temperature correction. What can be said is that very few current King Airs have any sort of self-compensating cold temperature correction built into their avionics systems. Some of the newest glass-cockpit packages do have the capability of applying internally calculated temperature-based altitude corrections to IAP segment altitudes and/or MDA/DA minimum altitudes. However, even those systems require the pilot to input the airport's current reported temperature into the system first. Advanced avionics manufacturers, such as Garmin with their various G1000-based

systems, are incorporating this capability into their systems via upgraded software versions. If you think your system might have such capabilities, check your software revision numbers and operating manuals to learn what, if any, such capabilities are available and how to utilize them appropriately. Chances are good you either don't have such capability in your aircraft or, if you do, a software upgrade will be required to ensure it is safe and legal to use under the current regulations. In some advanced avionics packages, the Autopilot and Vertical Navigation (VNAV) systems can even respect temperature corrected altitudes with proper pilot programming. But, for the vast majority of King Air operators, manual cold temperature altitude corrections are required.

Baro-VNAV systems used for LNAV/VNAV approaches usually have temperature limitations, as well (for both extreme cold and hot temperatures). However, Baro-VNAV temperature limits and CTRA temperature limits are mutually exclusive and should not be confused for one another. Baro-VNAV systems come in temperature compensated and non-temperature compensated varieties and each have their own set of limitations and operating rules. These have nothing to do with the CTRA list and the mandatory cold temperature altitude corrections at those airports. Thus, they are not within the scope of this article.

Expanding Your Knowledge

This article just scratches the surface, in order to make you aware of this important topic and the related regulatory change. Much more information is available in the following sources, including several detailed examples, using actual CTRA Approaches.

- Current AIM: Chapter 7, Section 2-3 (including Table 7-2-3).
- NOTAM 4-GEN-14 "Cold Temperature Restricted Airports" and subsequent revisions and updates via Notices to Airmen Publications (NTAP). Available within *www.faa.gov*.
- USDoT/FAA Information for Operators (InFO) Letter #15002, Dated: 9/14/2015.
- The National Business Aircraft Association (NBAA) has published several short articles on this topic, under the Aircraft Operations header, at *www.nbaa.org*.
- Numerous excellent internet articles exist, from basic announcements to very detailed articles with examples, mathematical formulas, and rules of thumb. These can be found via internet searches. However, be careful to verify such information via FAA-approved sources. KA

Matthew McDaniel is a Master & Gold Seal CFII, ATP, MEI, AGI & IGI. In 25 years of flying, he has logged over 15,000 hours total, over 5,500 hours of instruction-given, and over 2,500 hours in the King Air and BE-1900. As owner of Progressive Aviation Services, LLC, *(www.progaviation.com),* he has specialized in Technically Advanced Aircraft and Glass Cockpit instruction since 2001. Currently, he also flies the Airbus A-320 series for an international airline and holds six turbine aircraft type-ratings. Matt is one of less than 25 instructors in the world to have earned the "Master Certified Flight Instructor" designation for seven consecutive two-year terms. Mr. McDaniel can be contacted at (414) 339-4990 or *matt@progaviation.com*.