COLD WEATHER ALTITUDE CORRECTION

FMS Use of Barometric Altitude

The Air Data Computer (ADC) is calibrated for International Standard Atmosphere (ISA) conditions. Whenever the aircraft is operating in a standard atmosphere, the barometric altitude from the ADC will equal the aircraft altitude above mean sea level (MSL). This is also referred to as true altitude. ISA assumes constant lapse rates for change in pressure and temperature with an increase in altitude.

Barometric altitude from the ADC is used by the FMS for vertical navigation. The FMS constructs vertical paths and then uses the aircraft barometric altitude to determine if the aircraft is on path. Figure 3 illustrates the vertical path computation. As the figure shows, the FMS computes the distance to the runway by using the aircraft present position and the runway latitude and longitude. Using the tangent of the descent angle, the FMS computes the barometric altitude required for the aircraft to be on the path for the current distance to the runway. This altitude is compared to the aircraft barometric altitude. Differences appear as a vertical deviation displayed to the pilot on the Primary Flight Display (PFD).

Barometric Altitude Errors and Corrections

Many pilots do not realize that the vertical path flown by the FMS is susceptible to errors from the barometric altitude. These errors occur when the aircraft is operated in non standard atmospheric conditions. The two largest error contributors are non-standard pressure and temperature. To compensate for non-standard pressure, the altimeter is equipped with a barometric set knob. This allows adjustment of the altimeter for non standard pressures. Adjustments are performed by the flight crew when receiving a new altimeter setting. The second contributor to barometric altitude errors is non-standard temperature. Temperature errors occur when atmospheric temperatures are not equal to the standard atmosphere. Figure 1 shows the effect of temperature on barometric altitude. In warmer than standard conditions, the true altitude of the aircraft will be higher than the altitude displayed on the altimeter (also referred as indicated altitude). In a standard atmosphere, the true altitude of the aircraft will equal the indicated altitude. In colder than standard conditions, the true altitude of the aircraft will be lower than the indicated altitude. This is due to atmospheric pressure decreasing with altitude more rapidly in cold air than in warm air.

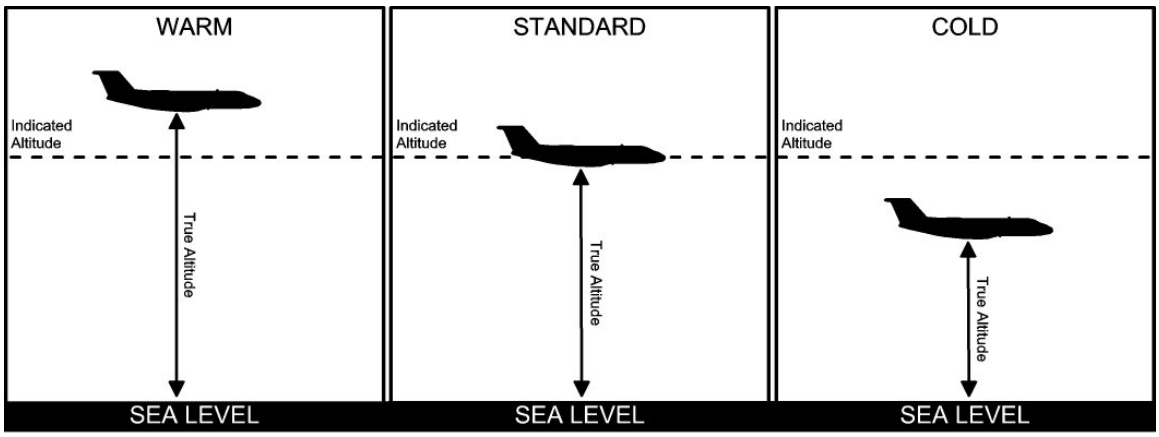

FIGURE 1

The magnitude of error created by colder than standard conditions is a function of the surface temperature and the aircraft altitude above the surface. FIGURE 2 provides the magnitude of the correction for cold temperatures and provides an example. Additional information on cold temperature correction can be obtained from Jeppesen Sanderson, Inc., Airway Manual, Canada region, Terminal section.

ALTITUDE CORRECTION CHART

A/D Temp °C	HEIGHT **ABOVE** THE ELEVATION OF THE ALTIMETER SOURCE (feet)													
	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
0°	0	20	20	20	20	20	40	40	40	60	80	120	160	200
-10°	20	20	40	40	40	60	60	80	80	120	160	240	320	400
-20°	20	40	40	60	80	80	100	100	120	180	240	360	500	620
-30°	40	40	60	80	100	120	140	160	160	260	340	500	680	860
-40°	40	60	80	100	120	160	180	200	220	320	440	660	880	1100
-50°	60	80	100	140	160	200	220	240	280	400	540	820	1100	1380
	Note: Values are to be added to published altitudes.													

Example:

AERODROME ELEV. 2262' AERODROME TEMP. -50°C

INDICATED	ALTITUDE	HAA	CORRECTION	ALTITUDE
PROCEDURE TURN	4000'	1738'	+460'	4460'
HAF	3300'	1038'	+280'	3580'
MDA STR IN	2840'	578'	+160'	3000'
CIRCLING MDA	2840'	578'	+160'	3000'

FIGURE 2

Operational Considerations

Few pilots consider the effects of cold temperature on FMS vertical navigation. It is an easy item to overlook and seldom discussed during approach briefings.
Items to consider when operating in extreme cold temperatures are as follows:

1. True altitude will be lower than indicated altitude. Therefore, the aircraft height above terrain will be decreased. The altitude correction chart should be used to compensate for these conditions when operating in the terminal and approach area.

2. FMS vertical approach paths will not align with Visual Approach Slope Indicators (VASI). If a 3° angle constraint is placed on a runway waypoint, the FMS will fly a 3° descent based upon barometric altitude. Due to the extreme cold temperature, the true altitude of the aircraft will be lower compared to standard atmospheric conditions. In this case, the FMS vertical path will be lower than the VASI geometric 3°
path resulting in low indications from the VASI.

3. ATC Minimum Vectoring Altitude (MVA) may not be increased due to cold temperatures. In Canada, MVAs are increased during cold weather operations. The FAA does not provide the same service. The flight crew should consider this if the aircraft is being vectored at MVA in extreme cold weather.

Why all the fuss now?

After explaining cold temperature compensation to pilots, it is not uncommon to be asked the question: Why all the fuss now? We have not used it before so why is it so important today? The answer lies in the future use of vertical path descents for approach operations. Industry is working to expand the operational capabilities of aircraft with vertical path capability. One of the operational benefits is obtaining lower minimums for approaches flown with a vertical path. To obtain these lower minimums, it is necessary for the aircraft to fly constant, stabilized, path descents at a specified angle for the final approach segment. This must be accomplished by the FMS regardless of the atmospheric conditions.

Honeywell is working with industry to determine the best solution to provide temperature correction for FMS vertical path descents. This solution will require the coordination of avionics manufacturers, procedure designers, air traffic specialists, aircraft manufacturers, certification agencies, and aircraft operators. Using expertise from all areas, it will be possible to develop an operational standard that can be used by all aircraft. We will keep you informed of developments in this area in future FMS Technical Newsletters.