How High are you?... Really

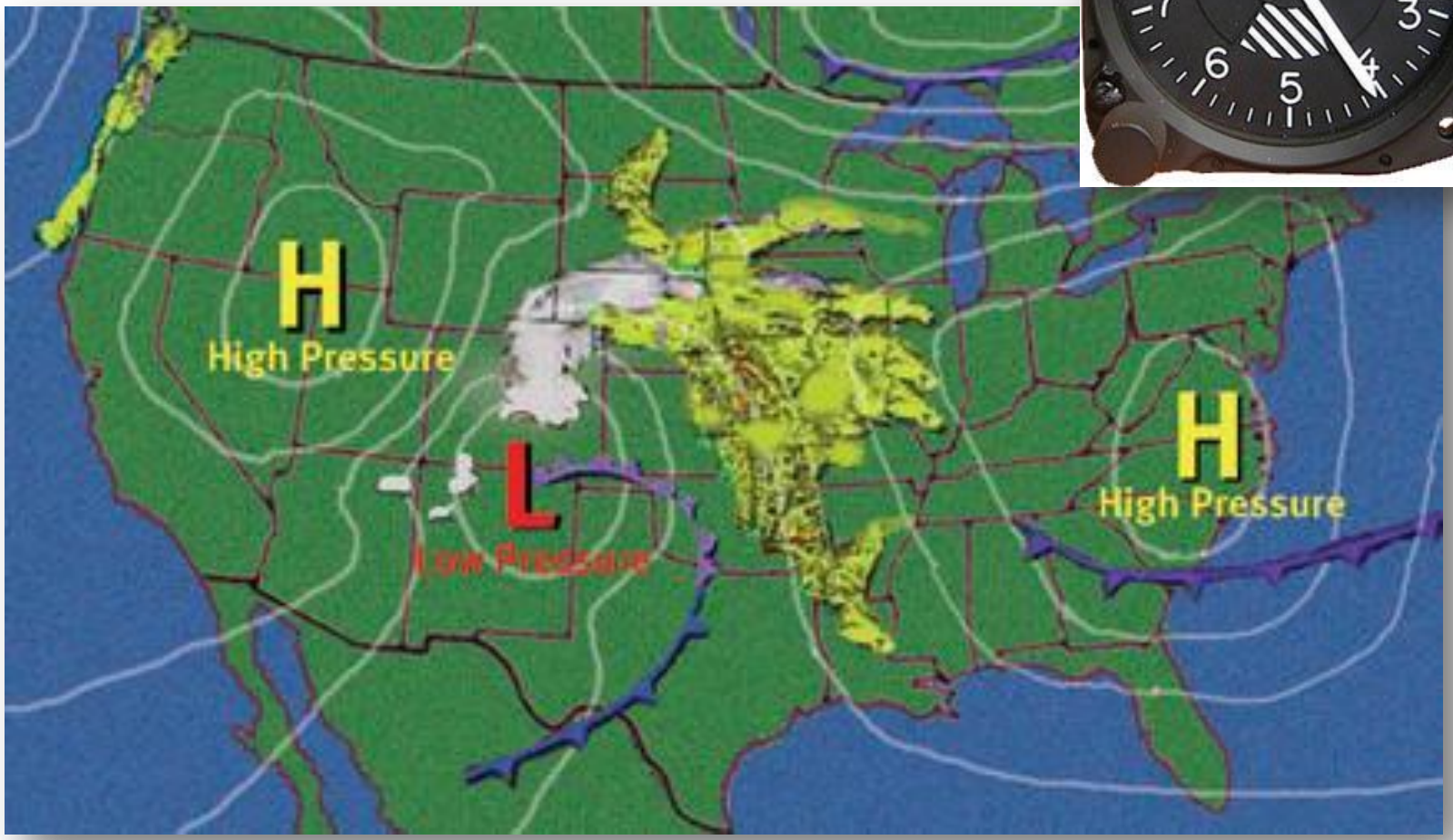
Temperature Compensation becomes mandatory in the US starting

September 17th, 2015

Woody Saland, PhD
Falcon Jet
Director Avionics Programs

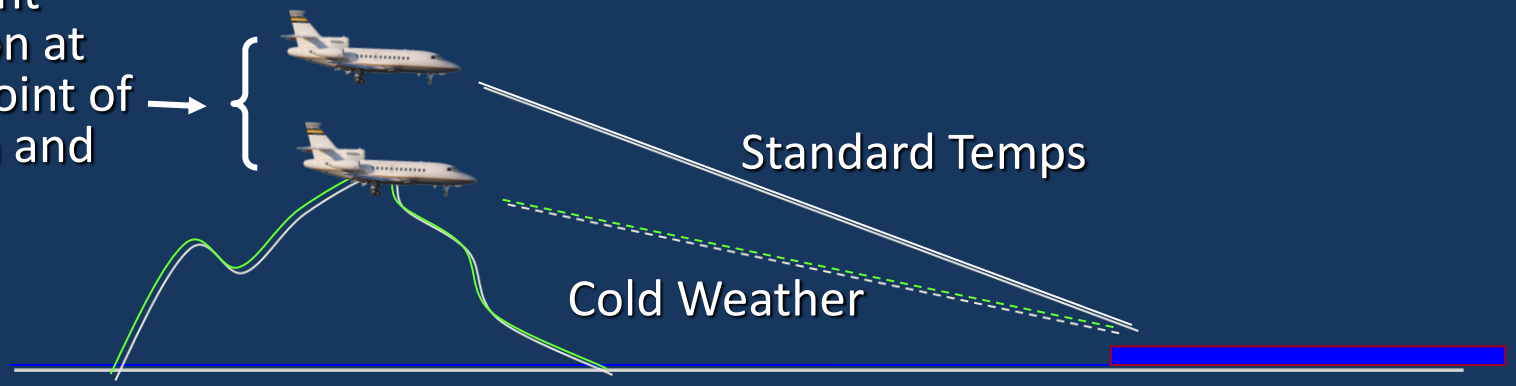
TUG September 16th, 2015

When going from a High to a Low look out Below !



But it's a similar problem going from Hot to Cold...

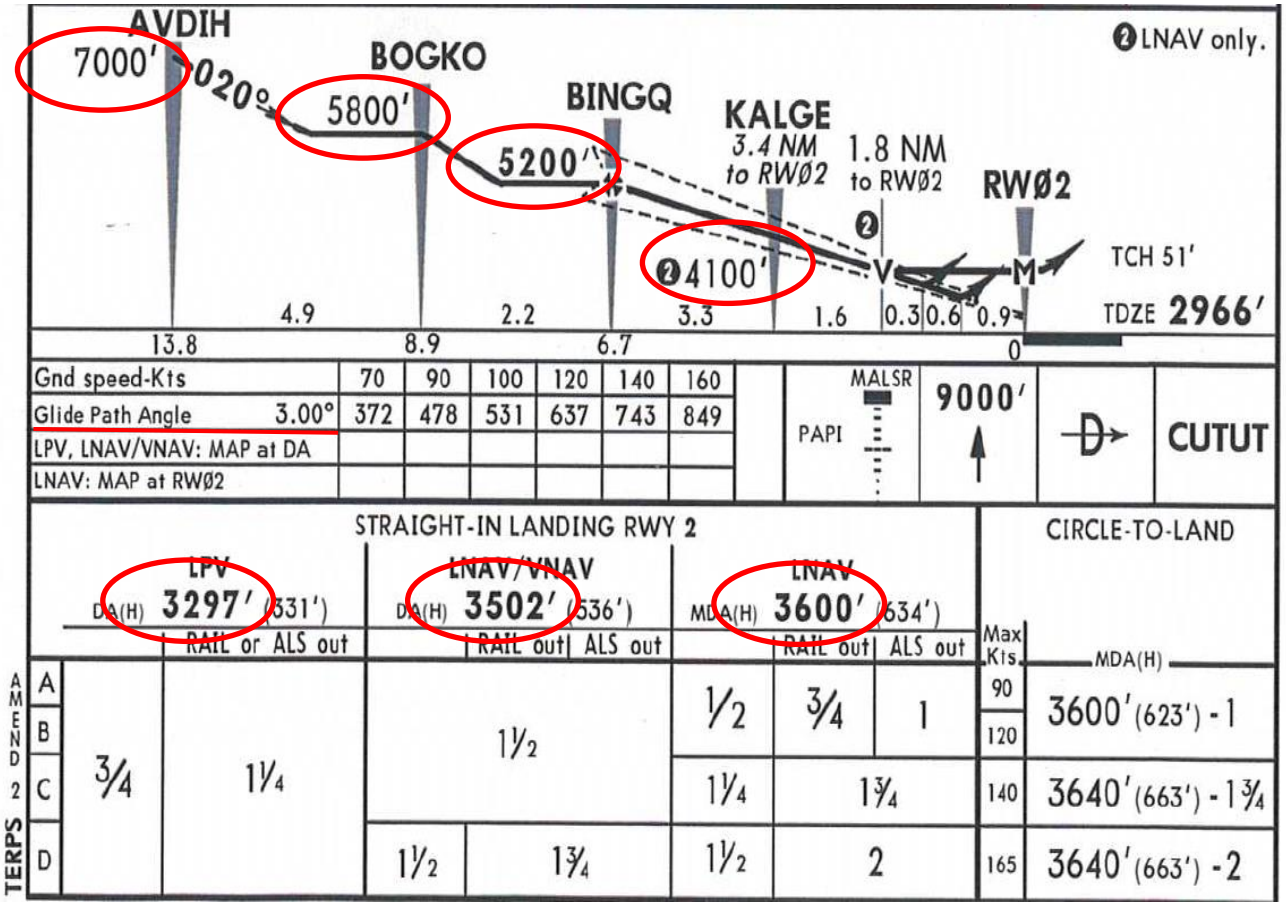
Need to add different correction at each waypoint of approach and miss



Two concerns: ROC Clearance
VNAV slope – PAPI

ROC: required obstacle clearance

Charted Procedures are based on True altitudes relative to Mean Sea Level as given for the airport (ie, MSL)



All of these altitudes are based on MSL of the airport and are thus True Altitudes

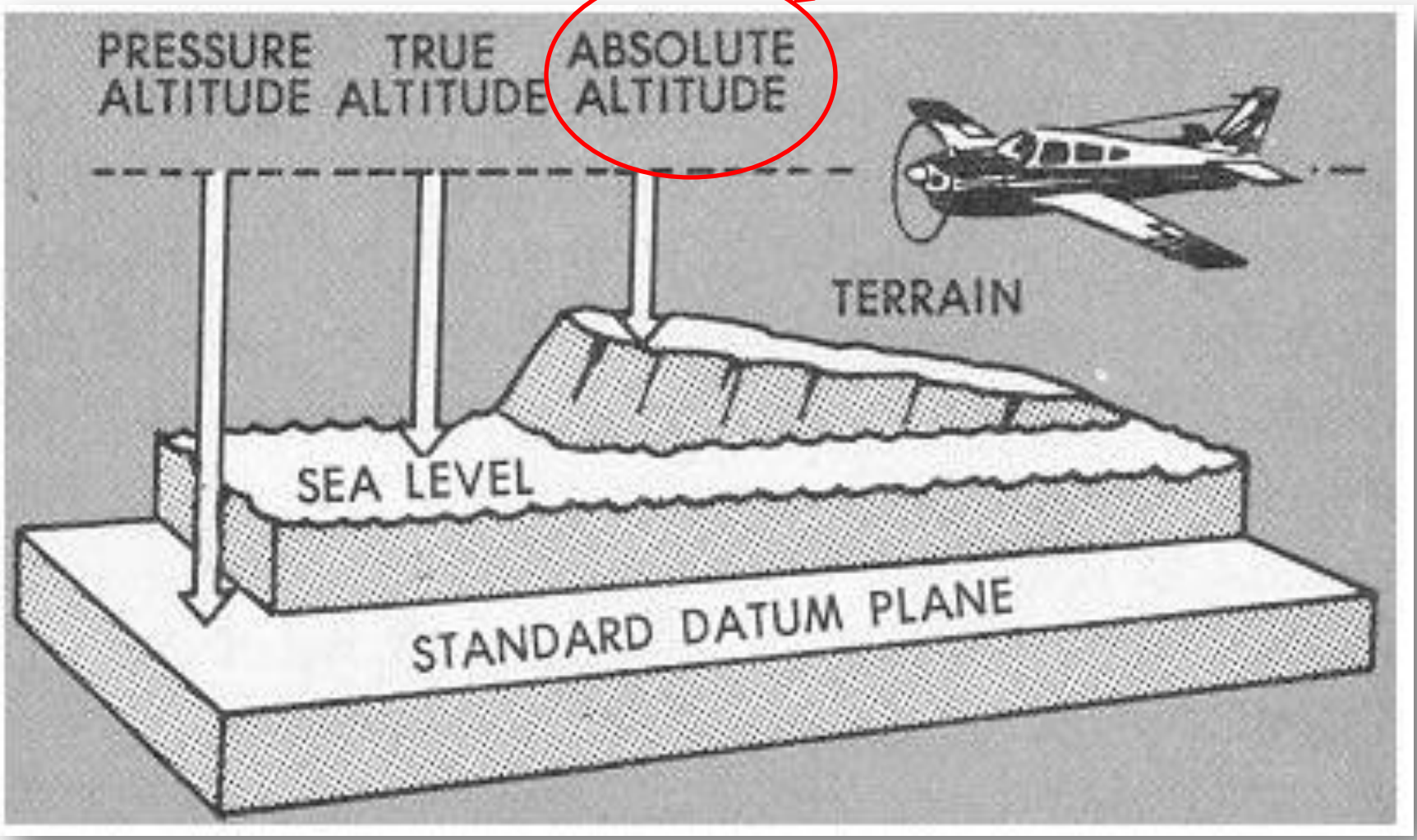
"*Mean sea level* was held fixed at the sites of 26 tide gauges, 21 in the U.S.A. and 5 in Canada. The datum is defined by the observed heights of mean sea level at the 26 tide gauges and by the set of elevations of all bench marks resulting from the adjustment. A total of 106,724 km of leveling was involved, constituting 246 closed circuits and 25 circuits at sea level."

Your Altitude relative to what ?

FL

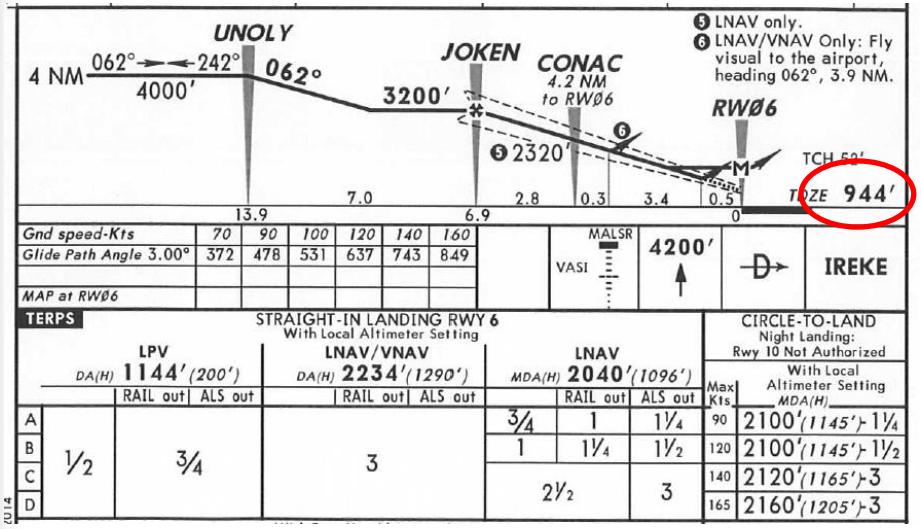
MSL

Radio Altimeter



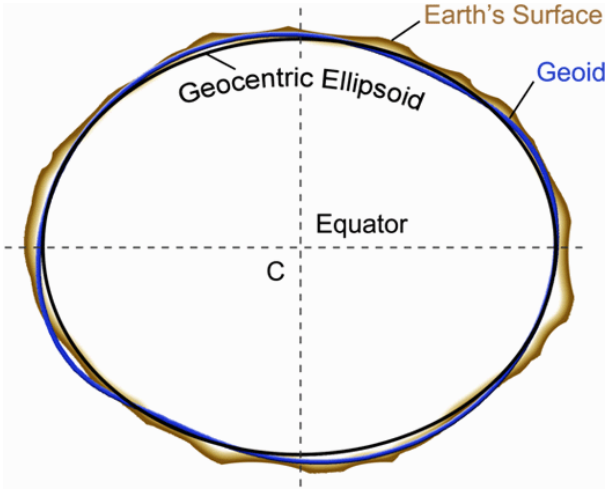
On board we can “see” three different altitudes Radar Altitude (absolute), Indicated Baro Altitude and GPS altitude

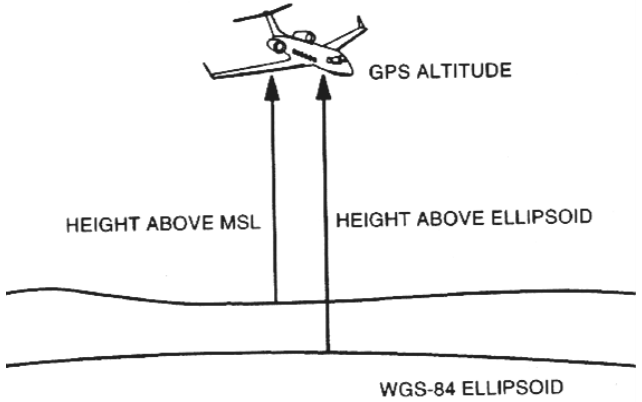
You’re adjusting the baro setting so that your Indicated Altitude will read the airport MSL when you land



Be Careful when using GPS Altitude

Notice there's no Knob to set for local altimeter setting

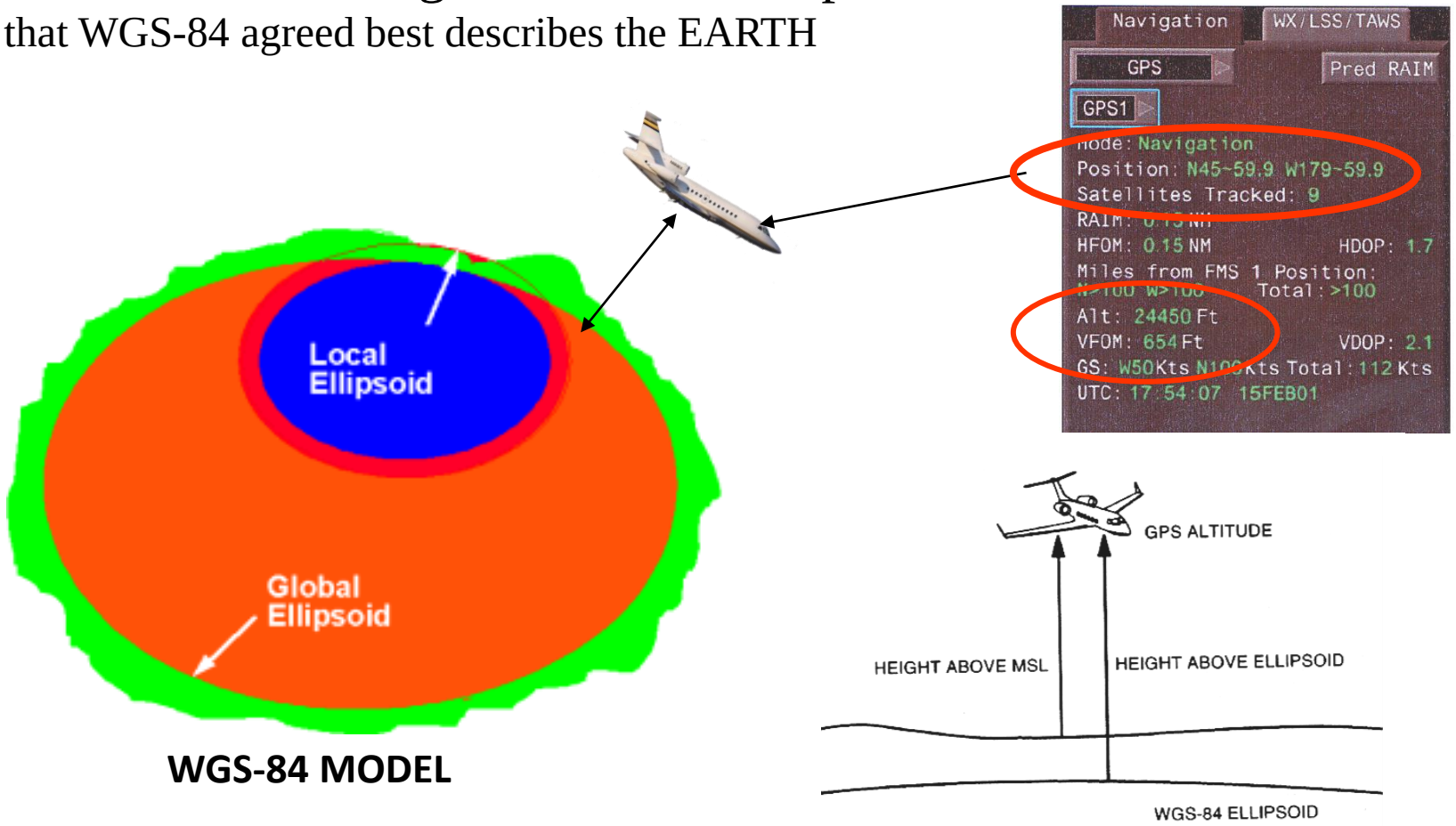




Why does the GPS altitude differ from Baro ?

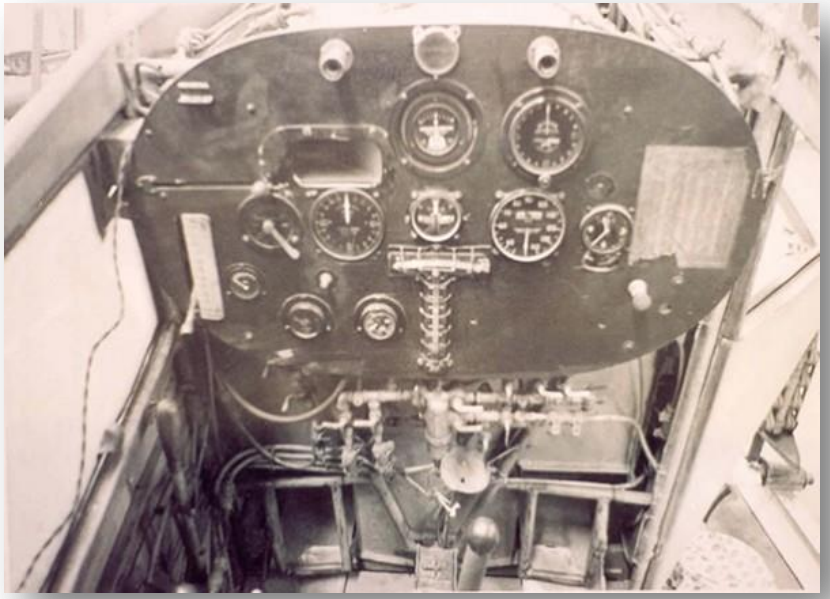
GPS Altitude is the height above the Ellipsoid

that WGS-84 agreed best describes the EARTH



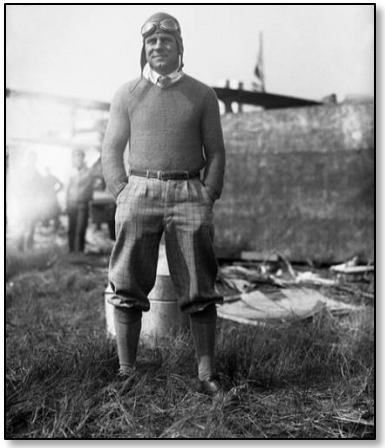
Up until 1928, before instrument flying, altimeters were non adjustable barometers

QFE: knob adjusted zero field elevation of departing airport

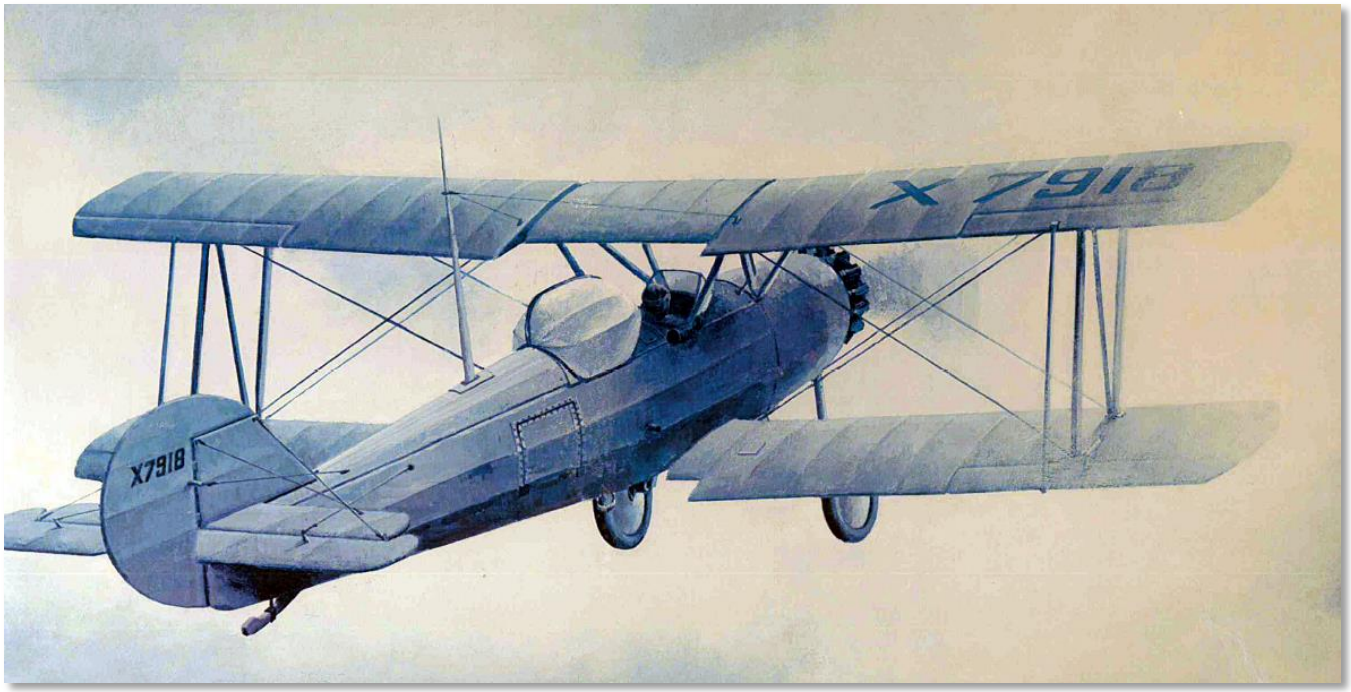


Charles Lindbergh's flight to Paris: May 20–21, 1927

September 24th, 1929 Jimmy Doolittle Proves you can fly "blind"

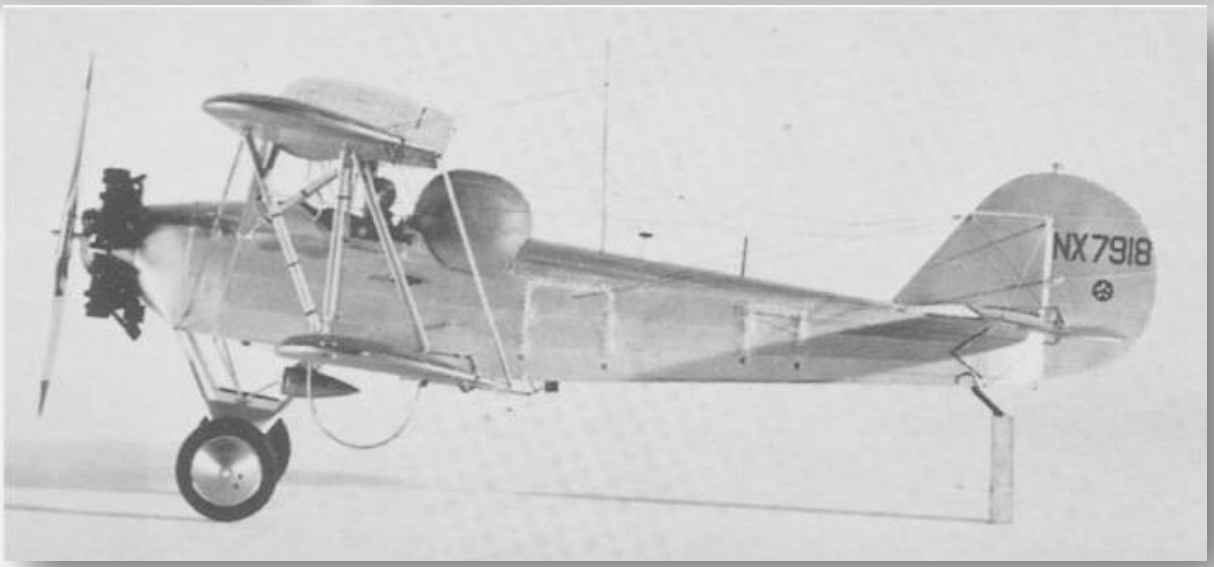


Using the Kollsman Altimeter, and a Sperry Gyroscope Company developed "artificial horizon."

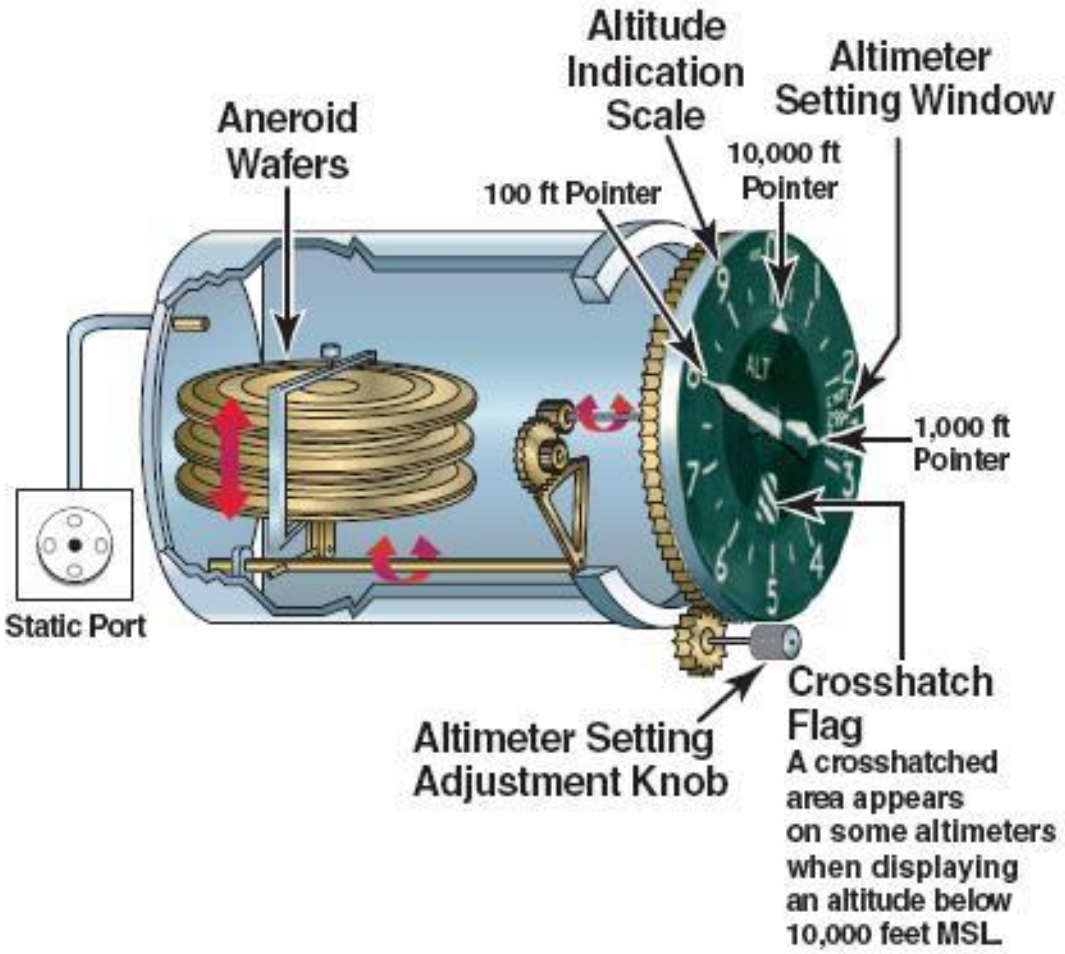


NY-2 airplane- Mitchell Field, NY


THE SPERRY HORIZON

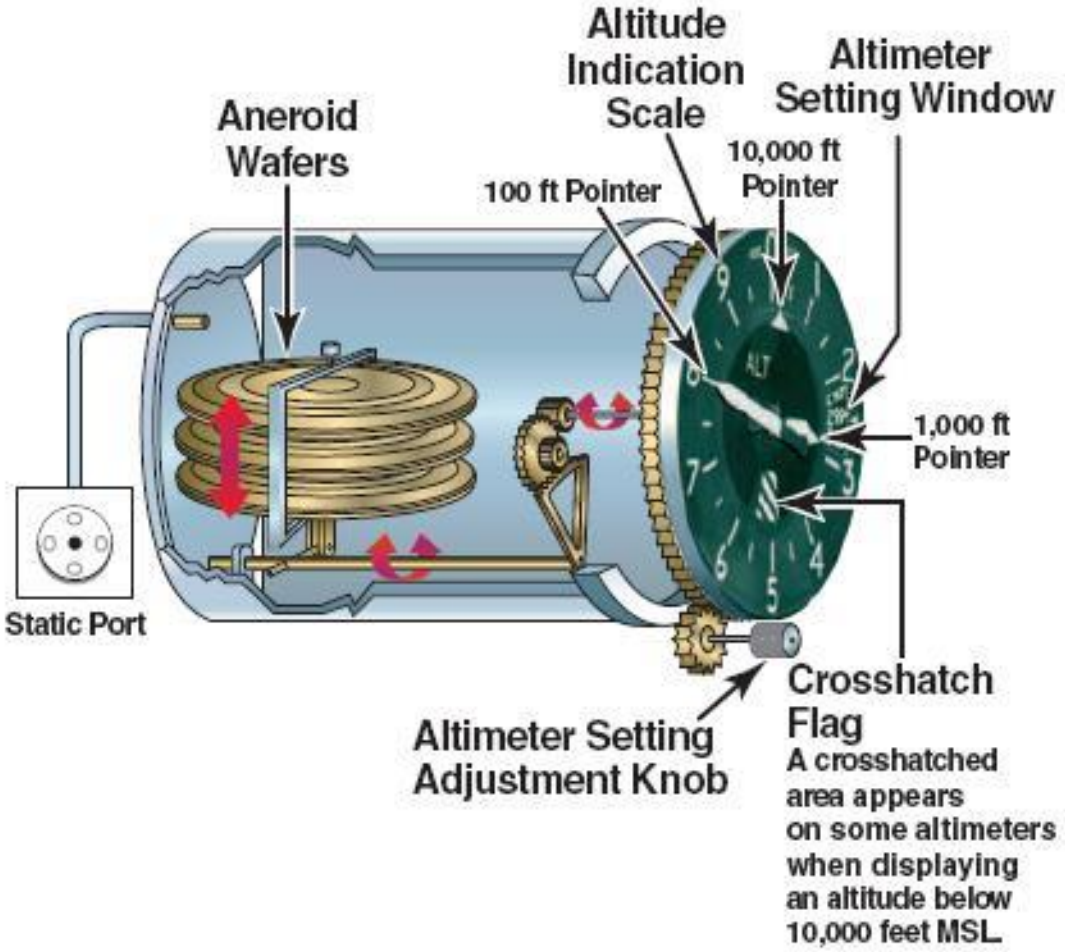

NX7918

the Sensitive, Barometric, Adjustable Altimeter



What's the name of this window ?

The Settings window is named after it's inventor, Paul Kollsman



Kollsman window

Paul Kollsman

Born: 2-22-1900
Died: 9-26-1982

Kollsman studied civil engineering in Stuttgart and Munich (Technical University Munich). In 1923 he emigrated from Germany to the USA. He worked as truck-driver until he found a position at Pioneer Instruments Co. in Brooklyn, New York. In 1928 he founded his own company, Kollsman Instruments Co., with $500 of seed money.

He was searching for the right opportunity to launch his product a long time until Jimmy Doolittle flight tested his instruments. The altimeter setting window of the sensitive aircraft altimeter is named the "Kollsman window" after him.

In 1939, Kollsman, who was then residing in Greenwich, Connecticut, sold his company for more than $4,000,000. In 1940 he purchased 800 acres (3.2 km^2) of land outside of Manchester Vermont from International Paper Company, and founded Snow Valley, which formally opened in January 1942, and was one of the earliest ski areas in the United States

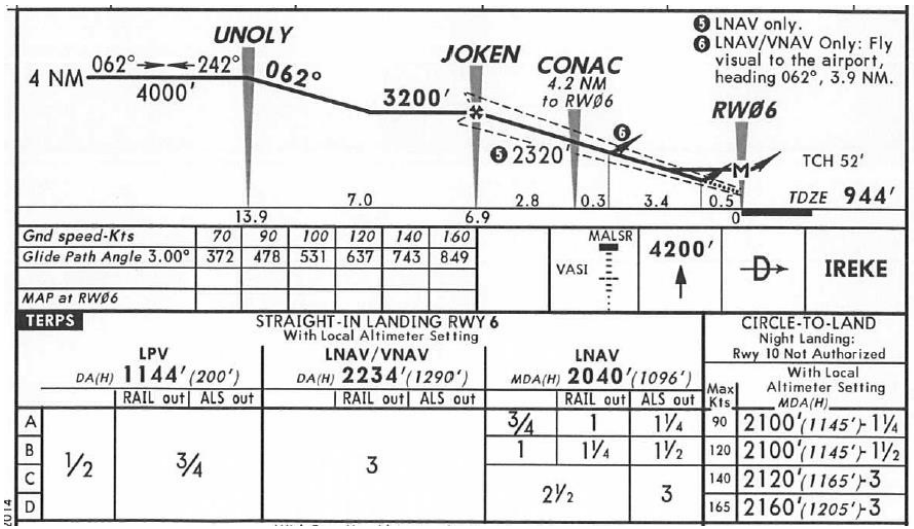
In 1945 Kollsman purchased The Enchanted Hill, a fabulous estate in Beverly Hills, California, which contained a Mediterranean Revival main house of 10,000 square feet (with 12 acres (49,000 m^2) of formal gardens) which Mr. Kollsman eventually augmented to 120 acres (0.49 $km^{2)}$

Microsoft co-founder Paul Allen acquired the estate from Kollsman's widow in 1997 for $20 million and razed the landmark house in 2000, with plans to build two 50,000-square-foot (4,600 m^2) mansions in its place.

KOLLSMAN AIRCRAFT INSTRUMENTS
PRODUCT OF
SQUARE D COMPANY
ELMHURST, NEW YORK • GLENDALE, CALIFORNIA

Kollsman
AN ELBIT SYSTEMS OF AMERICA COMPANY

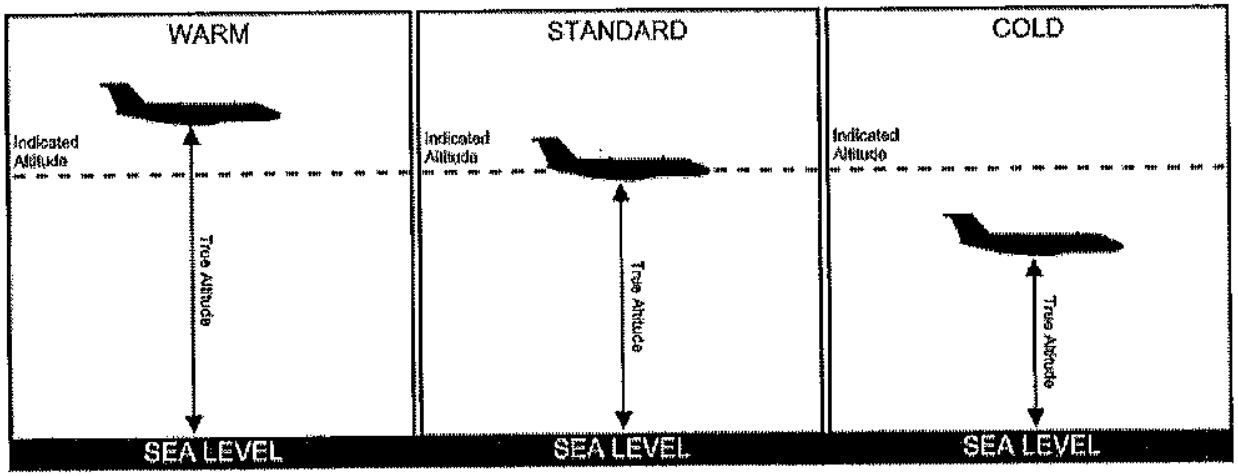
But there's only one knob, can't adjust for non-ISA temperature above the field !



With the one knob, I can at least assure when I land, I should see an airport altitude that is the charted MSL of the field – **<u>regardless of temperature !</u>**
So the closer to the field the more accurate the altimeter is

<u>But off the ground, our altimeter assumes a ISA adiabatic lapse rate for the temperature…. what if its colder (or hotter) than standard ?…… We'll be lower or higher than True….</u>

Indicated vs. True Altitude



So even though I've adjusted my altimeter so that when I land I'm at the field elevation, **aloft** it's still **"not true"** if the temperature is not ISA

FMS Use of Barometric Altitude

The Air Data System (ADS) is calibrated for International Standard Atmosphere (ISA) conditions. Whenever the aircraft is operating in a standard atmosphere, the barometric altitude from the ADS 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.

So What's the problem if the air is non-standard ?

At least three operational considerations

The effects of cold temperature on FMS vertical navigation is often negliged.

However when operating in extreme cold temperatures it should be considered that:

ROC

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.

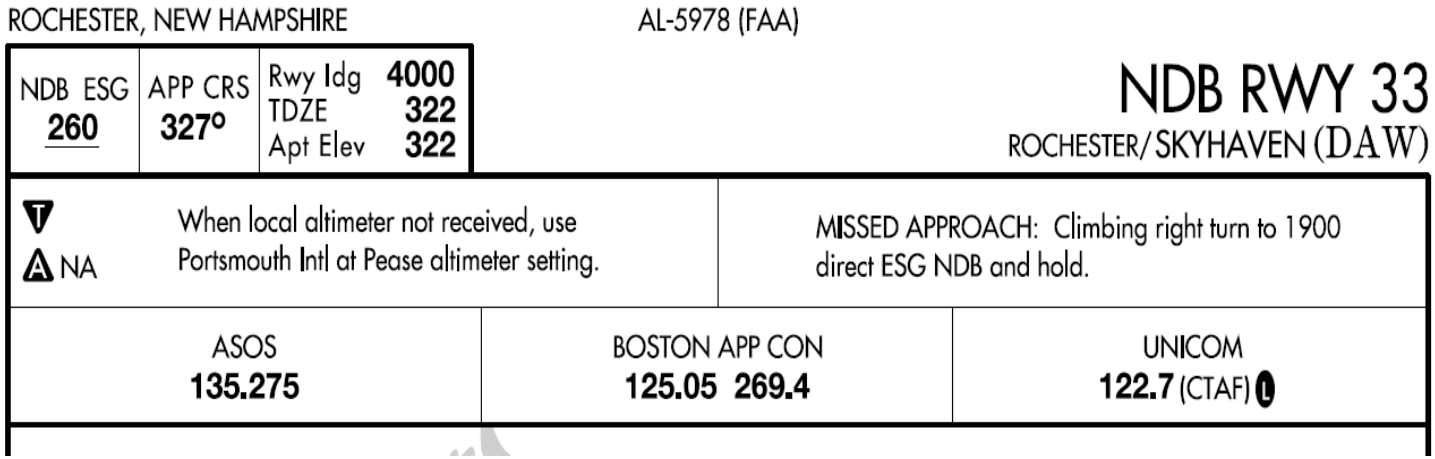
PATH

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.

MVA

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.

Historically, approaches didn't have temperature restrictions



ROCHESTER, NEW HAMPSHIRE AL-5978 (FAA)

NDB ESG	APP CRS	Rwy Idg	4000
260	327°	TDZE	322
		Apt Elev	322

NDB RWY 33

ROCHESTER/SKYHAVEN (DAW)

T A NA	When local altimeter not received, use Portsmouth Intl at Pease altimeter setting.
	MISSED APPROACH: Climbing right turn to 1900 direct ESG NDB and hold.

ASOS	BOSTON APP CON	UNICOM
135.275	125.05 269.4	122.7 (CTAF) L

Either you were on a precision Glide Slope where temperature doesn't matter, or the MDA was high enough that even in cold weather, there was no concern

What does the Inverse triangle “T” stand for ?

ROCHESTER, NEW HAMPSHIRE AL-5978 (FAA)

NDB ESG	APP CRS	Rwy Idg	4000
260	327°	TDZE	322
		Apt Elev	322

NDB RWY 33
ROCHESTER/SKYHAVEN (DAW)

T
A NA

When local altimeter not received, use Portsmouth Intl at Pease altimeter setting.

MISSED APPROACH: Climbing right turn to 1900 direct ESG NDB and hold.

ASOS	BOSTON APP CON	UNICOM
135.275	125.05 269.4	122.7 (CTAF)

L1

T 15008 **TAKEOFF MINIMUMS, (OBSTACLE) DEPARTURE PROCEDURES, AND DIVERSE VECTOR AREA (RADAR VECTORS)** T

INSTRUMENT APPROACH PROCEDURE CHARTS

T **IFR TAKEOFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES**

Civil Airports and Selected Military Airports

ALL USERS: Airports that have Departure Procedures (DPs) designed specifically to assist pilots in avoiding obstacles during the climb to the minimum enroute altitude, and/or airports that have civil IFR takeoff minimums other than standard, are listed below. Takeoff Minimums and Departure Procedures apply to all runways unless otherwise specified. Altitudes, unless otherwise indicated, are minimum altitudes in MSL.

But, a FAA Notam created Restricted Airports over terrain clearance concerns and it's mandatory !

December 11, 2014

Now its about ROC

Cold Temperature Restricted Airports

Cold Temperature Altitude Corrections

Subject: Cold temperature altitude corrections at airports with a published cold temperature restriction.

Purpose: To provide a list of 14 CFR Part 97 "Cold Temperature Restricted Airports" designated with a temperature restriction and guidance on when and how to calculate and apply altitude corrections to affected approach segment(s) during cold temperature operations. This list may also be found at the bottom of the, "Terminal Procedures Basic Search" page:

http://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dtpp/search/

Background: In response to aviation industry concerns over cold weather altimetry errors, the FAA conducted a risk analysis to determine if current 14 CFR Part 97 instrument approach procedures, in the United States National Airspace System, place aircraft at risk during cold temperature operations. This study applied the coldest recorded temperature at the given airports in the last five years and specifically determined if there was a probability that during these non-standard day operations, anticipated altitude errors in a barometric altimetry system could exceed the Required Obstacle Clearance (ROC) used on procedure segment altitudes. If a probability, of the ROC being exceeded, went above one percent on a segment of the approach, a temperature restriction was applied to that segment. In addition to the low probability that these procedures will be required, the probability of the ROC being exceeded precisely at an obstacle position is extremely low, providing an even greater safety margin.

Action:
Pilots must make an altitude correction to the published, "at", "at or above" and "at or below" altitudes on designated segment(s) (see list below), on all published procedures and runways, when the reported airport temperature is at or below the published airport cold temperature restriction.

U.S. Department
of Transportation

Federal Aviation Administration

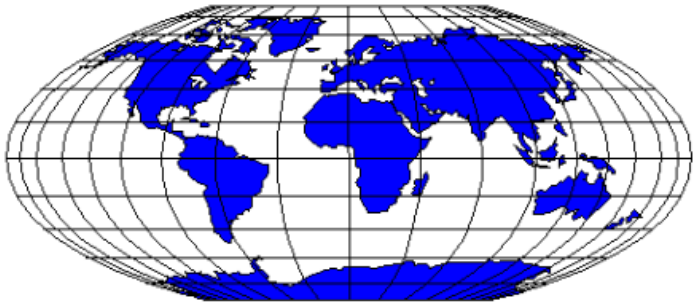
NOTICES TO AIRMEN

Domestic/International

September 17, 2015

Next Issue

October 15, 2015



*Notices to Airmen included in this publication are **NOT** given during pilot briefings unless specifically requested by the pilot. An electronic version of this publication is on the internet at http://www.faa.gov/air_traffic/publications/notices*

Air Traffic Products and Publications Team

Acronyms vs. Contractions (?)

NOTAM CONTRACTIONS

This list contains most of the commonly used contractions currently in use in Notices to Airmen (NOTAMS) and the standard aviation weather products, such as METAR/TAF, area forecasts, SIGMETs, AIRMETs, etc.

Contraction	*Decode*
	A
ABN	Aerodrome Beacon
ABV	Above
ACC	Area Control Center (ARTCC)
ACCUM	Accumulate
ACFT	Aircraft
ACR	Air Carrier
ACT	Active or Activated or Activity
ADJ	Adjacent
ADZD	Advised
AFD	Airport/Facility Directory
AGL	Above ground level
ALS	Approach Light System
ALT	Altitude
ALTM	Altimeter
ALTN	Alternate
ALTNLY	Alternately
ALSTG	Altimeter Setting
AMDT	Amendment
AMGR	Airport Manager
AMOS	Automatic Meteorological Observing System
AP	Airport
APCH	Approach
APL	Airport Lights
APP	Approach control or Approach Control Office
ARFF	Aircraft Rescue & Fire Fighting
ARR	Arrival or Arrive
ASOS	Automated Surface Observing System
ASPH	Asphalt
ATC	Air Traffic Control
ATCSCC	David J. Hurley Air Traffic Control System Command Center
ATIS	Automatic Terminal Information Service
AUTH	Authority
AUTOB	Automatic Weather Reporting System
AVBL	Available
AWOS	Automatic Weather Observing/Reporting System
AWY	Airway
AZM	Azimuth
	B

Contraction	*Decode*
CCLKWS	Counterclockwise
CCSA	Class C Surface Area
CD	Clearance Delivery
CDAS	Class D Airspace
CDSA	Class D Surface Area
CEAS	Class E Airspace
CESA	Class E Surface Area
CFR	Code of Federal Regulations
CGAS	Class G Airspace
CHG	Change
CIG	Ceiling
CK	Check
CL	Centerline
CLKWS	Clockwise
CLR	Clearance, clear(s), cleared to
CLSD	Closed
CMB	Climb
CMSND	Commissioned
CNL	Cancel
COM	Communications
CONC	Concrete
CPD	Coupled
CRS	Course
CTC	Contact
CTL	Control
	D
DALGT	Daylight
DCMSND	Decommissioned
DCT	Direct
DEGS	Degrees
DEP	Depart/Departure
DEPPROC	Departure procedures
DH	Decision Height
DISABLD	Disabled
DIST	Distance
DLA	Delay or delayed
DLT	Delete
DLY	Daily
DME	Distance Measuring Equipment
DMSTN	Demonstration

ATIS is a Contraction ?

CONTRACTION: a shortened form of a word or group of words, with the omitted letters often replaced in written English by an apostrophe, as e'er for ever, isn't for is not, dep't for department.

ACRONYM: a word formed from the initial letters or groups of letters of words in a set phrase or series of words and pronounced as a separate word, as Wac from Women's Army Corps, OPEC from Organization of Petroleum Exporting Countries, or loran from long-range navigation.

Latest update on the Cold Temp. Airports Notam

Sept. 17th, 2015

Pilots may use Real Time Mesocscale Analysis (RTMA): Alternate Report of Surface Temperature, for computing altitude corrections, when airport temperatures are not available via normal reporting. See InFO 15006 for additional information. The RTMA website is:

http://nomads.ncep.noaa.gov/pub/data/nccf/com/rtma/prod/airport_temps/

Pilots **without** temperature compensating aircraft must calculate and make a manual cold temperature altitude correction to the designated segment(s) of the approach using the AIM 7-2-3, ICAO Cold Temperature Error Table.

NOTE: No extrapolation above the 5000 ft column required. Pilots should use the 5000 ft "height above airport in feet" column for calculating corrections of greater than 5000ft above reporting station. Pilots will add correction(s) from the table to the segment altitude(s) and fly at the new corrected altitude. PILOTS MUST NOT MAKE AN ALTIMETER CHANGE to accomplish an altitude correction.

Pilots **with**, and using temperature compensating aircraft must ensure the system is on and operating for each segment requiring an altitude correction. Pilots may use the system for the entire approach if desired, pilots must advise ATC when correcting on the intermediate and/or missed approach segment. Pilots must ensure they are flying at the corrected altitude. If the system is not operating, the pilot is responsible to calculate and apply a manual cold weather altitude correction using the AIM 7-2-3 ICAO Cold Temperature Error Table. PILOTS MUST NOT MAKE AN ALTIMETER CHANGE to accomplish an altitude correction.

U.S. Department
of Transportation
**Federal Aviation
Administration**

InFO

Information for Operators

InFO 15006
DATE: 6/3/15

Flight Standards Service
Washington, DC

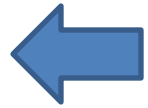
http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info

An InFO contains valuable information for operators that should help them meet certain administrative, regulatory, or operational requirements with relatively low urgency or impact on safety.

Subject: Real Time Mesocscale Analysis (RTMA): Alternative Report of Surface Temperature, Provided by the National Weather Service (NWS)

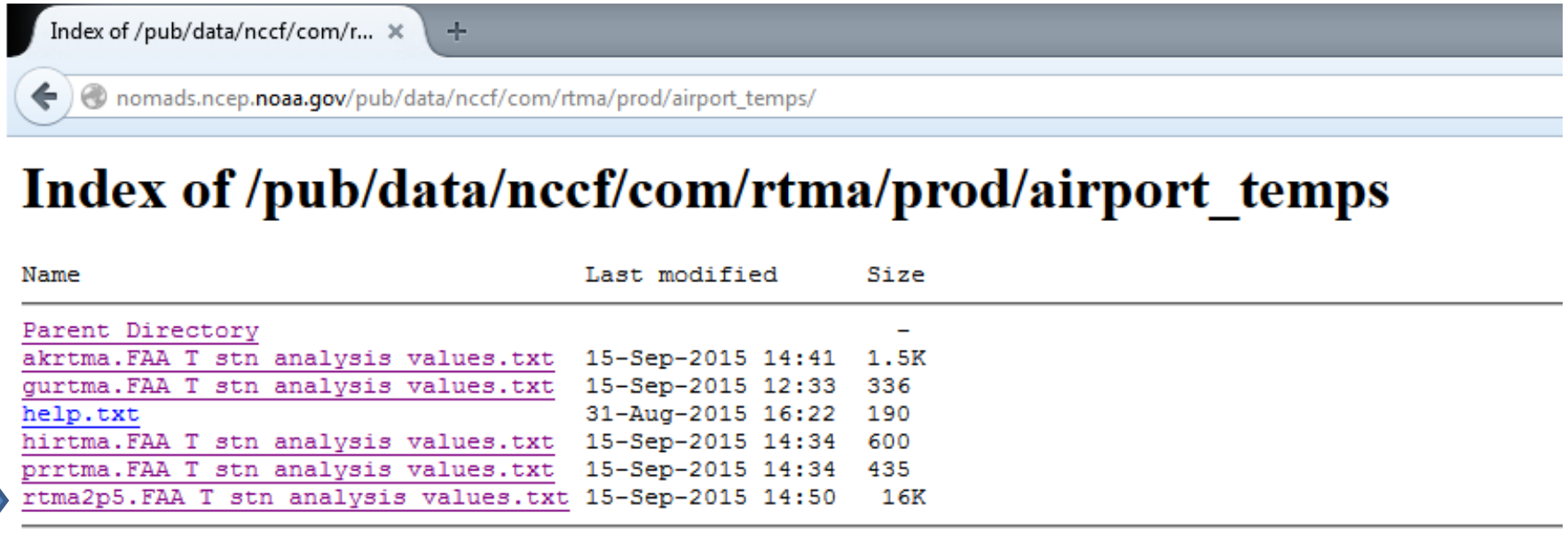
Purpose: This InFO provides information regarding the use of an RTMA when sensors on an automated weather system fail to report the surface temperature at an airport.

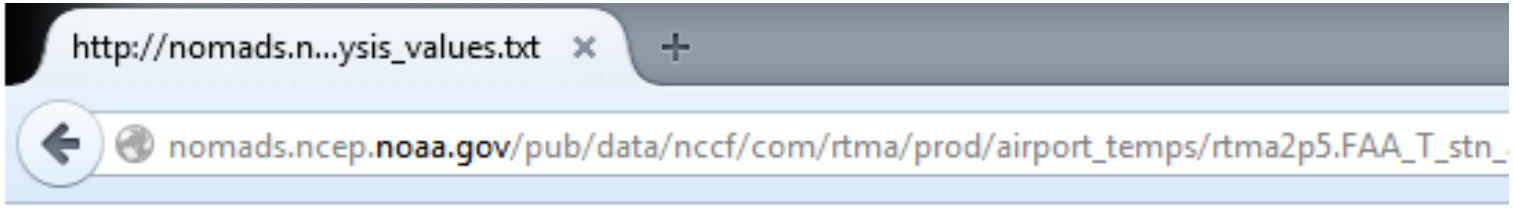
Background: Automated weather observation systems provide surface weather reports at many airports in the United States. Systems such as the Automated Surface Observing System (ASOS) or Automated Weather Observing System (AWOS) have reliably provided surface temperature reports at airports for over 25 years. Occasionally the sensors on these automated systems have been known to fail. Many airports utilize human weather observers to either back-up or augment these systems. However, at airports without a human weather observer to back-up or augment an automated system, the lack of temperature reports due to failed sensors has led to delays, diversions and cancellations in air carrier operations.



Discussion: In response to the issue of missing surface temperature reports due to failed sensors, the Federal Aviation Administration (FAA) solicited the assistance of the NWS in developing an alternative system for reporting surface temperature that operators, pilots, and aircraft dispatchers could easily use. The NWS responded by developing an RTMA surface temperature report that provides a simple hourly report of surface temperature at an airport, every hour, 24 hours a day. RTMA temperature reports are now available at approximately 540 Title 14 of the Code of Federal Regulations (14 CFR) Part 139

If you type in the address in the INFO you get:





****
RTMA temperature in degrees Celsius at select station locations
COMPUTED: 1445Z 15 Sep 2015
VALID: 1445Z 15 Sep 2015 to 1545Z 15 Sep 2015
****

station	Lat	Lon	T
KABE	40.65	-75.43	19.25
KABI	32.42	-99.68	20.34
KABQ	35.05	-106.62	18.13
KABR	45.45	-98.43	20.29
KABY	31.53	-84.18	22.27
KACK	41.25	-70.07	21.59
KACT	31.62	-97.22	23.55
KACV	40.98	-124.10	9.47
KACY	39.45	-74.57	22.23
KAEX	31.33	-92.55	23.47
KAFW	32.98	-97.32	22.39
KAGS	33.37	-81.97	20.63
KAHN	33.95	-83.32	18.60
KAIA	42.05	-102.80	17.88
KALB	42.75	-73.80	19.49
KALN	38.90	-90.05	19.84

Compliance is Mandatory !

InFO

Information for Operators

InFO 15002
DATE: 2/10/15

Flight Standards Service
Washington, DC

Subject: Implementation of cold temperature altitude corrections at "Cold Temperature Restricted Airports" found in Notice to Airmen Publication (NTAP)

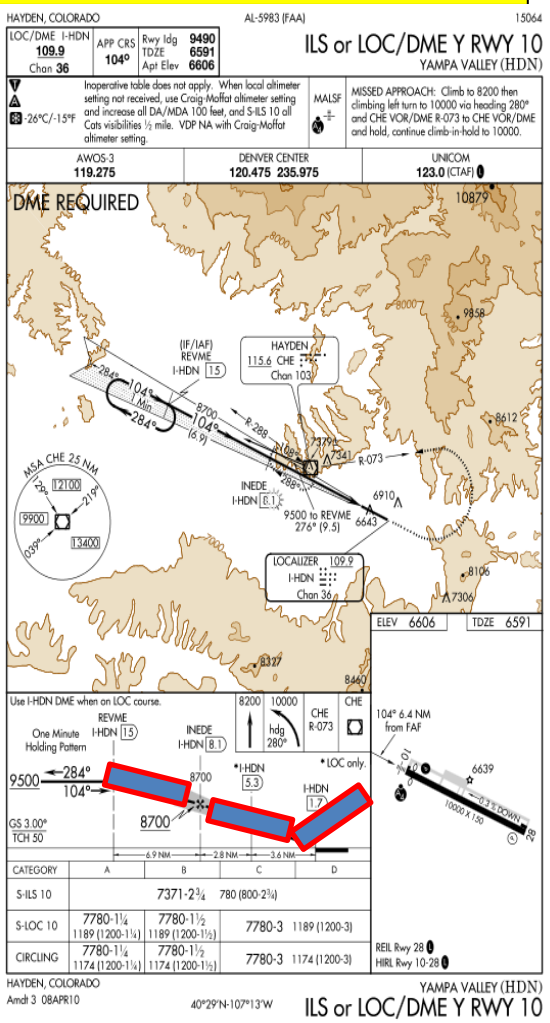
Mandatory compliance with these procedures will be in effect Sep 17, 2015.

A -XX°C icon will be incrementally added to airport approach plates, beginning Mar 5, 2015. The icon indicates a cold temperature altitude correction will be required on an approach when the reported temperature is, "at or below" the temperature specified for that airport. The one exception to this procedure is Chicago Midway Intl (KMDW). Only operations to 22L and 22R will be affected. Altitude corrections will not be required on any approach to any other landing runway at KMDW.

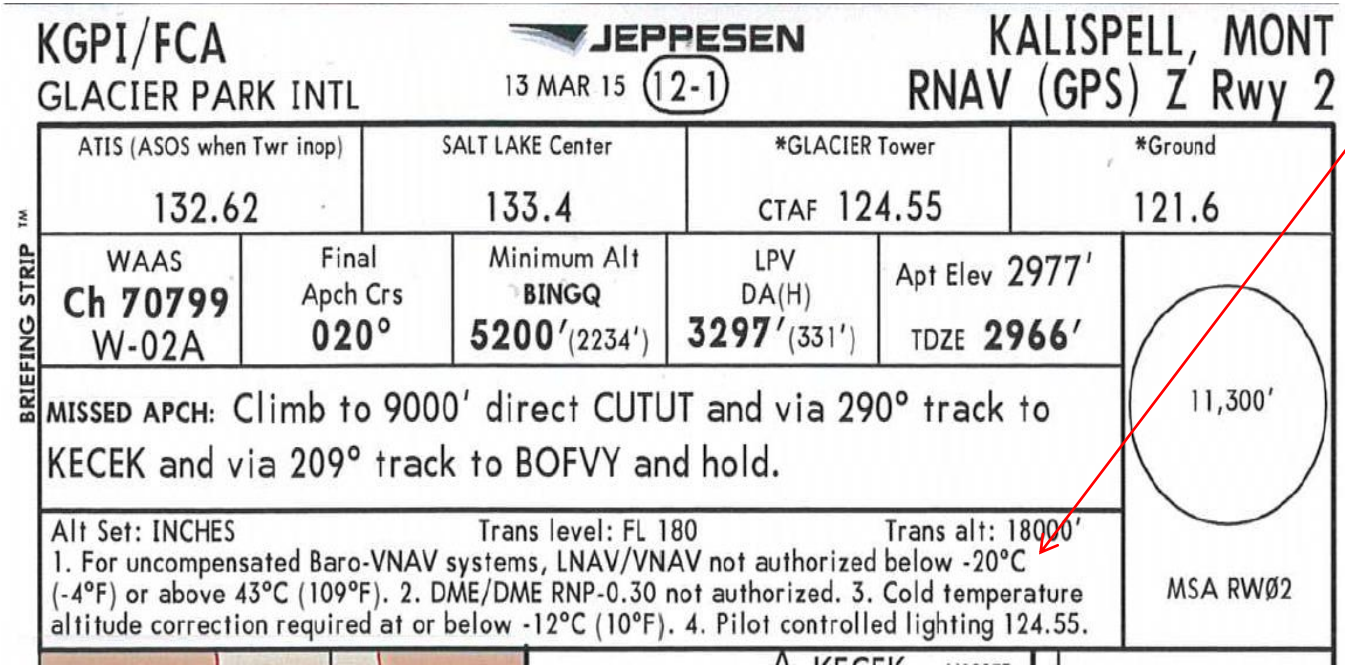
The affected airports list should be reviewed to determine relevance to each operator's operations (airports), as well as which segment(s) of associated approaches will require an altitude correction. Temperatures for Cold Temperature Restricted Airports are completely separate from the temperatures published on area navigation (RNAV) approaches. Temperature restrictions on RNAV approaches for lateral navigation (LNAV)/vertical navigation (VNAV) minima must be followed, even if it is warmer than the temperature associated with the "snowflake" icon.

The FAA has introduced the concept of temp. comp per segment

			SEGMENTS		
Identifier	Airport Name	Temperature	Intermediate	Final	Missed Appr
Alaska					
PABL	Buckland	-38C/-36F	X		
KCAG	Craig-Moffat	-31C/-24F	X		
KEEO	Meeker Coulter Field	-17C/1F		X	
KEEO	Meeker Coulter Field	-28C/-18F	X		
KEGE	Eagle County Rgnl	-17C/1F	X		
KEGE	Eagle County Rgnl	-25C/-13F			X
KGUC	Gunnison-Crested Butte Rgnl	-28C/-18F	X		
KGUC	Gunnison-Crested Butte Rgnl	-34C/-29F			X
KHDN	Yampa Valley	-26C/-15F	X		X
Montana					
KBTM	Bert Mooney	-22C/-8F	X		
KBZN	Bozeman Yellowstone Intl	-12C/10F	X		
KDLN	Dillon	-18C/0F	X		
KGPI	Glacier Park Intl	-12C/10F	X		



Let's look at Kalispell, Mt



KGPI/FCA
GLACIER PARK INTL

JEPPESEN
13 MAR 15 (12-1)

KALISPELL, MONT
RNAV (GPS) Z Rwy 2

BRIEFING STRIP ™

ATIS (ASOS when Twr inop)	SALT LAKE Center	*GLACIER Tower	*Ground
132.62	133.4	CTAF 124.55	121.6

WAAS	Final Apch Crs	Minimum Alt	LPV DA(H)	Apt Elev 2977′
Ch 70799 W-02A	020°	BINGQ 5200′(2234′)	3297′(331′)	TDZE 2966′

MISSED APCH: Climb to 9000′ direct CUTUT and via 290° track to KECEK and via 209° track to BOFVY and hold.

11,300′

Alt Set: INCHES Trans level: FL 180 Trans alt: 18000′

1. For uncompensated Baro-VNAV systems, LNAV/VNAV not authorized below -20°C (-4°F) or above 43°C (109°F). 2. DME/DME RNP-0.30 not authorized. 3. Cold temperature altitude correction required at or below -12°C (10°F). 4. Pilot controlled lighting 124.55.

MSA RWØ2

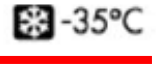
Below -4°F can't use LNAV/VNAV Min unless TComp

But…

below 10°F you must use Tcomp … but only the intermediate Segment…..

The temperature restriction at a "Cold Temperature Restricted Airport" is mutually exclusive from the charted temperature restriction published for "uncompensated baro-VNAV systems" on 14 CFR Part 97 RNAV (GPS) and RNAV (RNP) approach plates. The charted temperature restriction for uncompensated baro-VNAV systems is applicable to the final segment LNAV/VNAV minima. The charted temperature restriction must be followed regardless of the cold temperature restricted airport temperature.

New Snowflake Symbol….

Cold Temperature Restricted Airports: Airports are listed by ICAO code, Airport Name, Temperature Restriction in Celsius/Fahrenheit and affected Segment. One temperature may apply to multiple segments. *Italicized airports have two segments with different temperature restrictions.* The warmest temperature will be indicated on Airport IAPs next to a snowflake symbol, 

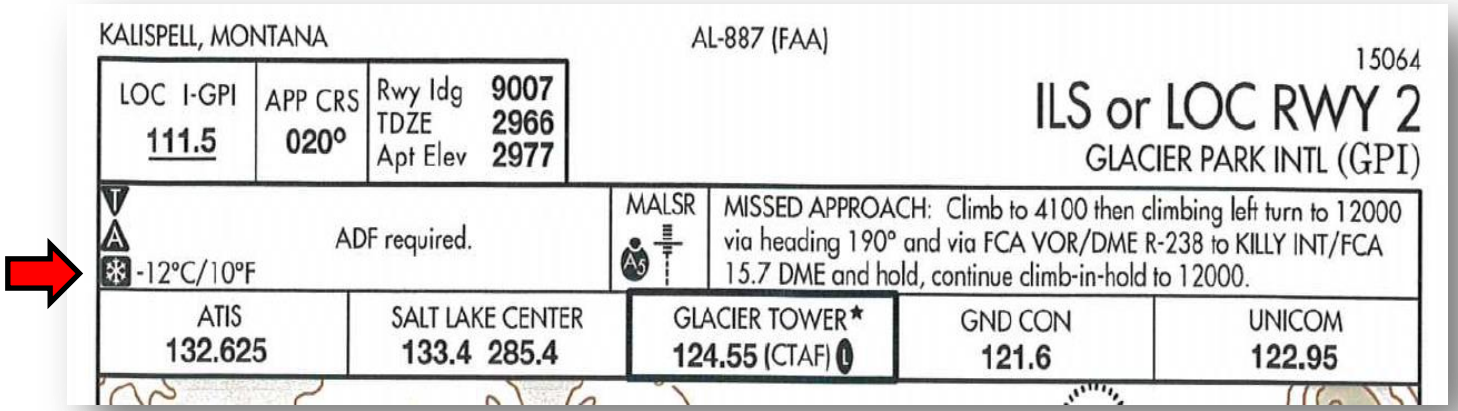
in the United States Terminal Procedure Publication.

So if I saw a snowflake and the temperature was below stated, without a full T Comp system, only listed segments need to be adjusted

			SEGMENTS		
Identifier	Airport Name	Temperature	Intermediate	Final	Missed Appr
KELM	*Elmira/Corning Rgnl*	-16C/3F		X	
KELM	*Elmira/Corning Rgnl*	-27C/-17F	X		

Although no "X" , it's implied that the final segment also must be compensated.

Except that Jepp doesn't use a snowflake !



KALISPELL, MONTANA

AL-887 (FAA)

15064

LOC I-GPI	APP CRS	Rwy Idg	9007
111.5	020°	TDZE	2966
		Apt Elev	2977

ILS or LOC RWY 2

GLACIER PARK INTL (GPI)

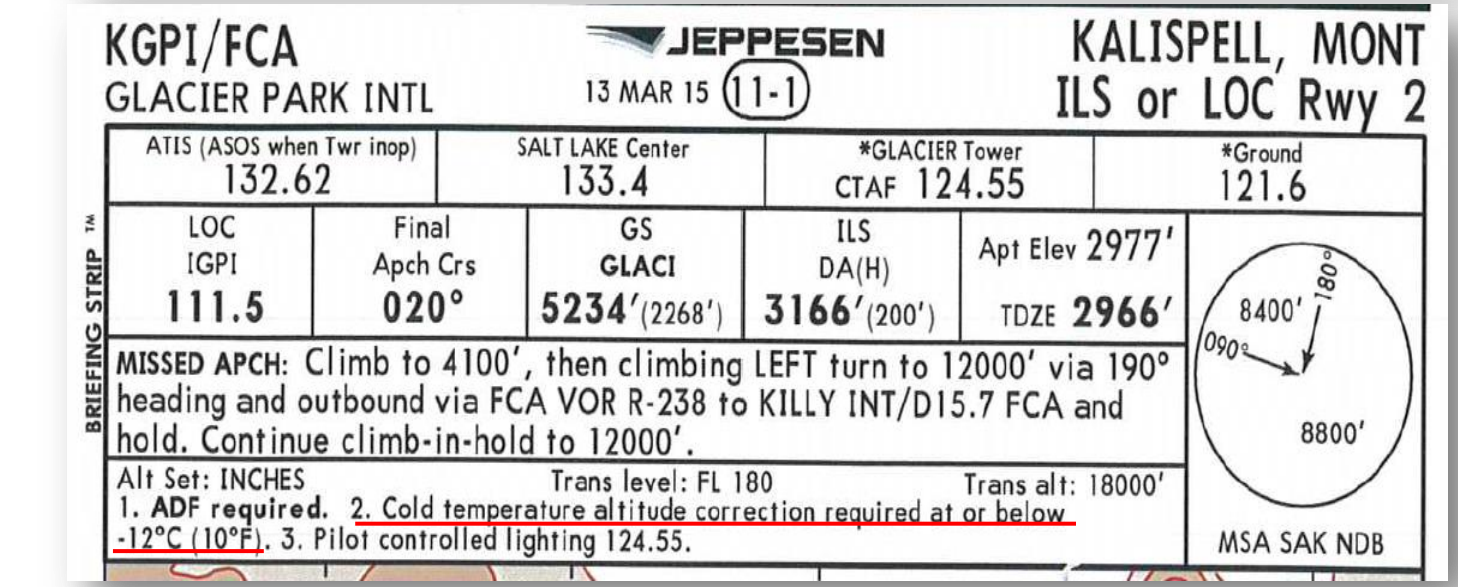
TA -12°C/10°F

ADF required.

MALSR

MISSED APPROACH: Climb to 4100 then climbing left turn to 12000 via heading 190° and via FCA VOR/DME R-238 to KILLY INT/FCA 15.7 DME and hold, continue climb-in-hold to 12000.

ATIS	SALT LAKE CENTER	GLACIER TOWER*	GND CON	UNICOM
132.625	133.4 285.4	124.55 (CTAF)	121.6	122.95



KGPI/FCA

GLACIER PARK INTL

JEPPESEN

13 MAR 15 (11-1)

KALISPELL, MONT

ILS or LOC Rwy 2

BRIEFING STRIP™

ATIS (ASOS when Twr inop)	SALT LAKE Center	*GLACIER Tower	*Ground
132.62	133.4	CTAF 124.55	121.6

LOC IGPI	Final Apch Crs	GS GLACI	ILS DA(H)	Apt Elev 2977′
111.5	020°	5234′ (2268′)	3166′ (200′)	TDZE 2966′

MISSED APCH: Climb to 4100′, then climbing LEFT turn to 12000′ via 190° heading and outbound via FCA VOR R-238 to KILLY INT/D15.7 FCA and hold. Continue climb-in-hold to 12000′.

Alt Set: INCHES Trans level: FL 180 Trans alt: 18000′

1. **ADF required.** 2. Cold temperature altitude correction required at or below -12°C (10°F). 3. Pilot controlled lighting 124.55.

MSA SAK NDB

Look at how temp. comp. is required for an ILS at a temp. restricted airport

Pilots are to tell ATC when they are using “cold temperature ops”

The following are examples of appropriate pilot-to-ATC communication when applying cold-temperature altitude corrections.

- On initial check-in with ATC providing approach clearance: Hayden, CO (example below).
- Intermediate segment: “Require 10600 ft. for cold temperature operations until BEEAR”,
- Missed Approach segment: “Require final holding altitude, 10600 ft. on missed approach for cold temperature operations”
- Pilots cleared by ATC for an instrument approach procedure; “Cleared the RNAV RWY 28 approach (from any IAF)”. Hayden, CO (example below).
- Intermediate Segment: “Level 10600 ft. for cold temperature operations inside HIPNA to BEEAR”
- Pilots are not required to advise ATC if correcting on the final segment only. Elko, NV (example below).

The ICAO Cold Temp. Error Table

Pilots **without** temperature compensating aircraft are responsible to calculate and make a manual cold temperature altitude correction to the designated segment(s) of the approach using the AIM 7-2-3, ICAO Cold Temperature Error Table.

Pilots **with** temperature compensating aircraft must ensure the system is on and operating for each segment requiring an altitude correction. Pilots must ensure they are flying at corrected altitude. If the system is not operating, the pilot is responsible to calculate and apply a manual cold weather altitude correction using the AIM 7-2-3 ICAO Cold Temperature Error Table. PILOTS SHOULD NOT MAKE AN ALTIMETER CHANGE to accomplish an altitude correction.

Pilots must report cold temperature corrected altitudes to Air Traffic Control (ATC) whenever applying a cold temperature correction on an intermediate segment and/or a published missed approach final altitude. This

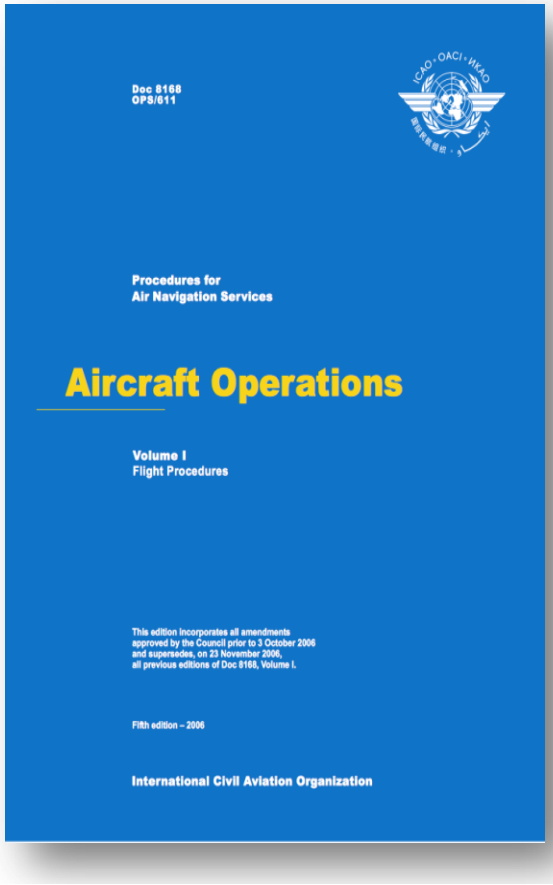
TBL 7-2-3

ICAO Cold Temperature Error Table

Reported Temp °C	Height Above Airport in Feet													
	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

Doesn't mention the table is only accurate for sea level airports….

Table comes from ICAO Document



4.3.1 Approx. correction…. Increase waypoint height by 4% for every 10°C below standard temp.

4.3.2 Tables are for sea level airports. Therefore they are conservative for higher airports….

4.3.1 Requirement for temperature correction. The calculated minimum safe altitudes/heights must be adjusted when the ambient temperature on the surface is much lower than that predicted by the standard atmosphere. In such conditions, an approximate correction is 4 per cent height increase for every 10°C below standard temperature as measured at the altimeter setting source. This is safe for all altimeter setting source altitudes for temperatures above -15°C.

4.3.2 Tabulated corrections. For colder temperatures, a more accurate correction should be obtained from Tables III-1-4-1 a) and III-1-4-1 b). These tables are calculated for a sea level aerodrome. They are therefore conservative when applied at higher aerodromes. To calculate the corrections for specific aerodromes or altimeter setting sources above sea level, or for values not tabulated, see 4.3.3, "Corrections for specific conditions".

Dassault Codde 2 has added the full ICAO table

- COMPUTE softkey ..... Clicked on
- WPT LIST: Final Approach Point (FAP) proposed altitude ..... Cross-checked vs following table

F2000EX EASY	NORMAL OPERATIONS	03-10-34B
CODDE 2	SYSTEMS	PAGE 7 / 12
DGT88899	NAVIGATION *A/C WITH M3254 AND M5000*	ISSUE 2

Airfield OAT		Height above the elevation of the airfield (ft)												
°C	°F	200	300	400	500	600	700	800	900	1,000	1,500	2,000	3,000	4,000	5,000
50	122	-20	-40	-40	-60	-60	-80	-80	-100	-100	-160	-220	-320	-440	-540
40	104	-20	-20	-40	-40	-40	-60	-60	-80	-80	-120	-160	-240	-320	-400
30	86	-20	-20	-20	-20	-40	-40	-40	-40	-60	-80	-100	-160	-200	-260
20	68	0	0	0	0	-20	-20	-20	-20	-20	-20	-40	-60	-60	-80
10	50	0	0	0	0	20	20	20	20	20	20	40	60	80	100
0	32	0	20	20	20	40	40	40	60	60	80	120	160	220	280
-10	14	20	20	40	40	60	60	80	80	100	140	200	280	380	480
-20	-4	20	40	60	60	80	100	120	120	140	200	280	420	560	700
-30	-22	40	60	80	100	120	140	140	160	180	280	380	560	760	940
-40	-40	40	80	100	120	140	160	180	220	240	360	480	720	960	1,220
-50	-58	60	80	120	140	180	200	240	260	300	440	580	880	1,200	1,500

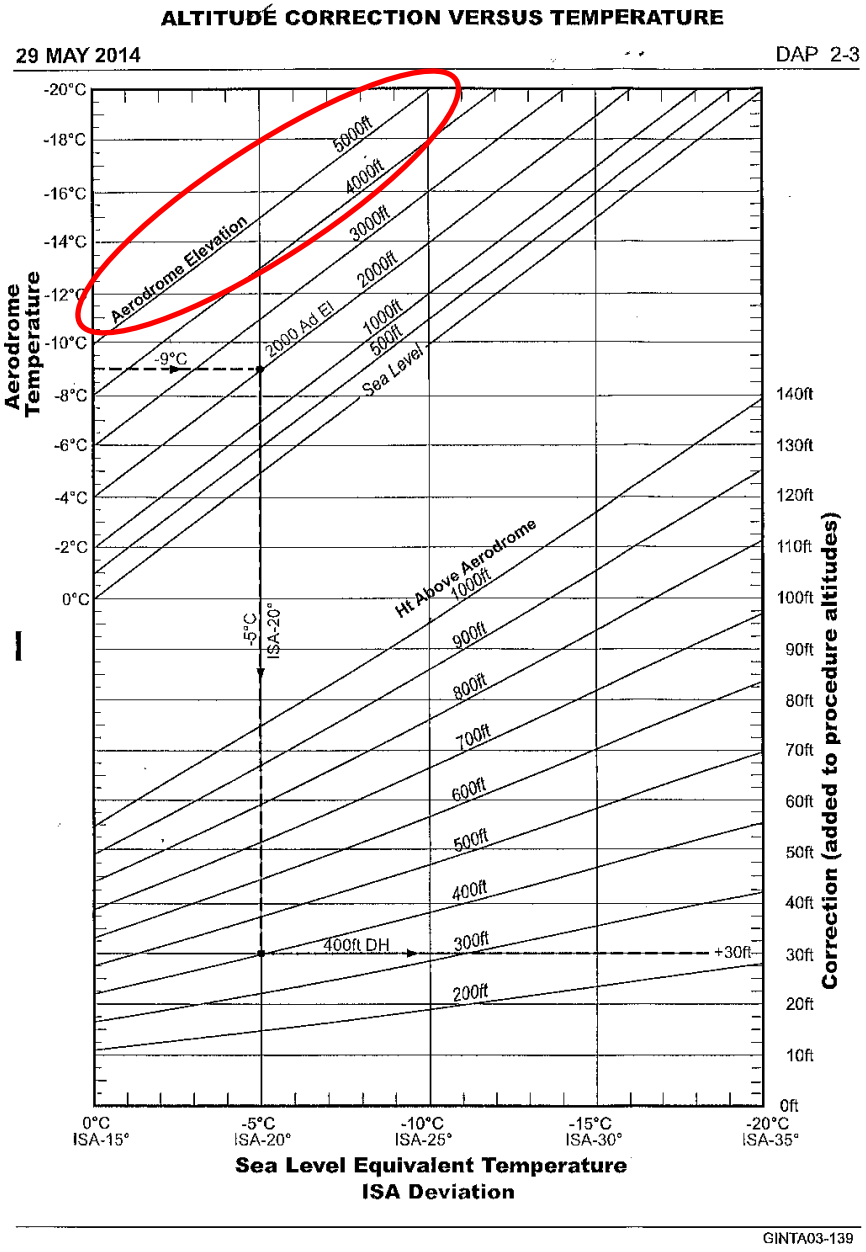
Note: Rounded values given for an airfield altitude of 0 ft.

FAA

Note the additive goes to zero at the field

To be more accurate you need to consider the field elevation

Look how Australia's chart has you enter using first the airport elevation first, then height and temp…. More accurate than the "famous" table



airservices

EASy II Temp. Comp. - computes all approach and missed waypoints

The altitude temperature compensation is computed by the FMS as follows (note that the function will iterate the following equation five times to close on the final altitude correction):

$$h_{CORR} = (15.0 - t_0)/\text{lapseRate} * \log (1.0 + \text{lapseRate} * h/(288.16 + \text{lapseRate} * \text{runway elevation}))$$

where;

- h_{CORR} = Temperature Compensation altitude correction (initialized to zero)
- t_0 = $t_{destination}$ - lapseRate * runway elevation
- $t_{destination}$ = Temperature at destination
- h = original altitude + h_{CORR} - runway elevation
- lapseRate = -0.0065° C per meter (-0.00198° C per foot)

For all the approach and missed waypoints….. EASy II is the most accurate and complete way to compensate

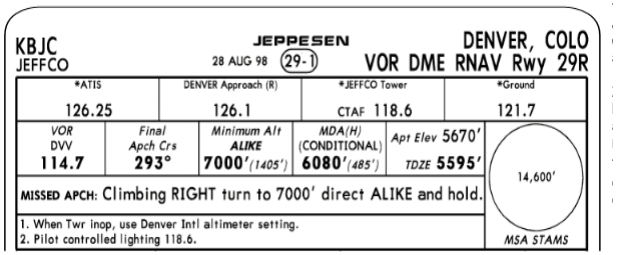
But the numbers will be lower than the table (which is “conservative”)

Minimum Sector Altitudes

US…… No policy
Canada …… MSAs adjusted for temp.
France …… ATC adjusts by table due to temp. within a band
Switzerland …… Don't adjust MSA… adjust QNH
Czech Republic ……between Nov-March… 200'added to MSA
Norway…… All MSAs use a design of ISA -15°C rather than ISA

Minimum Sector Altitudes

Most Important — the minimum sector altitudes (MSA) listed in the heading data of Jeppesen approach charts are included for **emergency** use only in the United States and most countries. An MSA provides at least 1,000 feet of obstruction clearance within a 25-nautical mile radius of the fix designated below the MSA circle. The 1000-foot clearance applies in both mountainous and non-mountainous areas.



KBJC JEFFCO — JEPPESEN 28 AUG 98 (29-1) — DENVER, COLO VOR DME RNAV Rwy 29R

*ATIS	DENVER Approach (R)	*JEFFCO Tower	*Ground
126.25	126.1	CTAF 118.6	121.7

VOR DVV	Final Apch Crs	Minimum Alt ALIKE	MDA(H) (CONDITIONAL)	Apt Elev 5670′
114.7	293°	7000′(1405′)	6080′(485′)	TDZE 5595′

MISSED APCH: Climbing RIGHT turn to 7000′ direct ALIKE and hold.

1. When Twr inop, use Denver Intl altimeter setting.
2. Pilot controlled lighting 118.6.

14,600′ MSA STAMS

MVA

According to ICAO PANS OPS, minimum vectoring altitudes shall be corrected for temperature. The temperature correction shall be based on seasonal or annual minimum temperature records. In turn, ATC authorities are required, as per ICAO PANS ATM, 8.6.5.2, Note 2, "to provide the controller with minimum altitudes corrected for temperature effect".

Temperature Comp. for Departures ?

FALCON 7X	PERFORMANCES	05-15-05
CODDE2	TAKE-OFF	PAGE 3 / 22
DGT105609	PART 1 - CALCULATION PARAMETERS	ISSUE 8

TOPOGRAPHIC ALTITUDE VS ZP (ΔISA CORRECTION)

In ISA condition, pressure altitude equals topographic altitude. As soon as real atmospheric conditions differ from ISA model, pressure altitude is modified as follows:

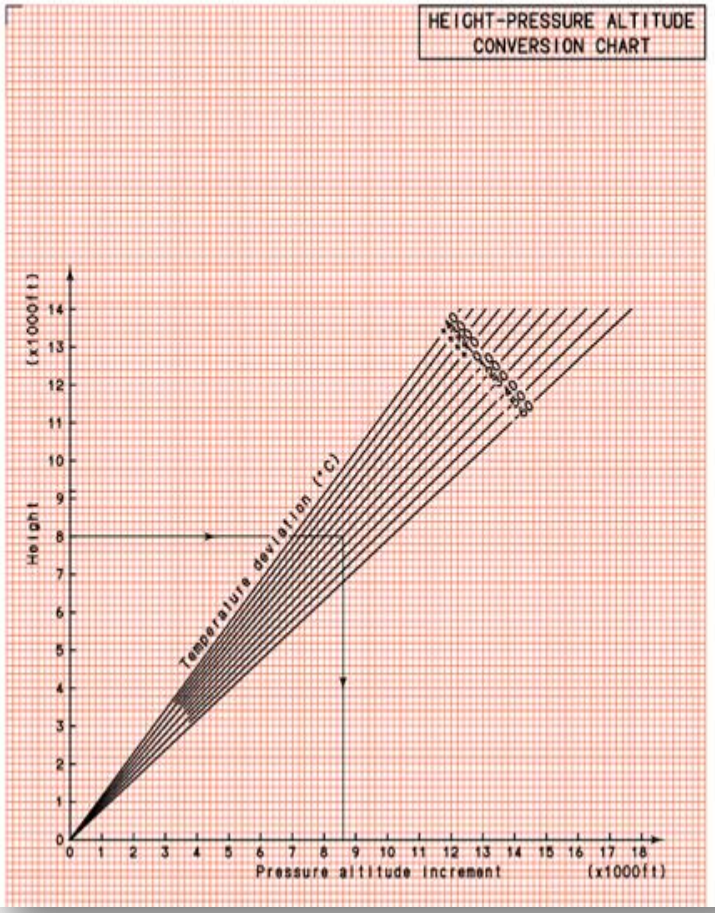
- QNH higher (lower) than 1013.25 hPa moves upward (downward) all isobars. Topographic distance between two isobars is still equal to pressure height.
- Temperature higher (lower) than ISA expands (contracts) isobars so that topographic distance between 2 isobars is higher (lower) than pressure height. Following formula can be used to determine pressure height:

$$\Delta Zp = \frac{Topographic\_Height}{1 + \frac{\Delta ISA}{288.15}}$$

ΔZp : Height based on isobars

ΔISA : deviation of temperature from ISA

F2000EX Airplane Flight Manual	PERFORMANCE CONVERSION CHARTS Height-pressure altitude conversion chart	5-250-30 PAGE 1 / 2 Issue 6



A good reference source

Eddie Sez (www.code7700.com)
James Albright

Code 7700 LLC Normals Abnormals G450 Academics

Altimetry

Altimeter Temperature Correction

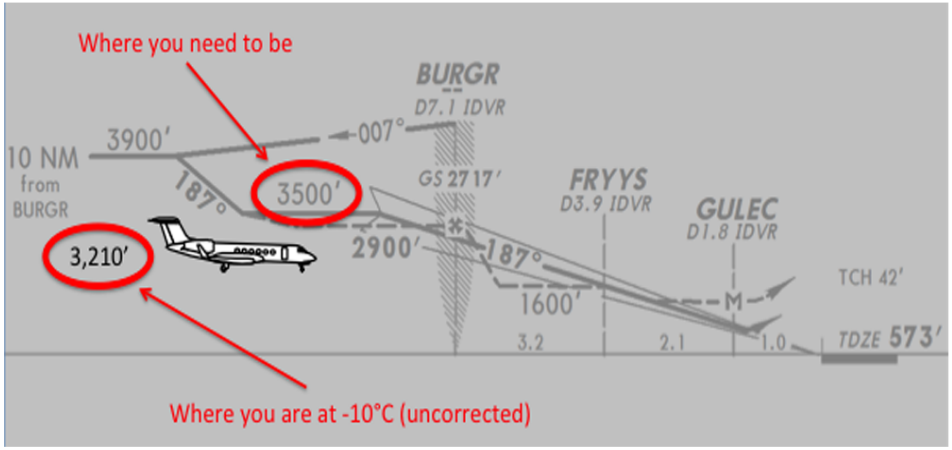


Figure: KLEB Altimeter Temperature Correction Example, from Eddie's notes.

Eddie Sez:

Your altimeter is a marvelous piece of machinery that is highly accurate throughout almost the entire flight envelope of your aircraft. Almost, but not all. When it gets very cold, the error can be enough to lower your actual altitude well below any minimums. You, ATC, or your aircraft will have to make adjustments.

I've included the math here just to show there is science behind the method. But, as a pilot, what you need to know is that when it gets cold, your altimeter puts the airplane lower than it should. In most cases the error is insignificant. The colder than 0°C it is, and the higher you are than the airport's elevation, the more significant the error. You can use a set of tables, included below and in Jepps, or if your aircraft is allowed to automatically compensate, you can do that. But if you make the corrections, you need to let ATC know. They might be giving you corrected altitudes or your correction could put you in the way of aircraft that are not correcting.

Conclusions:

- Starting tomorrow, some 200+ airports will be classified as Cold Temperature Restricted Airports (check list before you go, or look on the chart)
- Bring a copy of the FAA sea level airports Temp. Comp. Chart along with you if you are going to one of these airports
- The additives are mandatory only for the Segments listed in the Notam (bring along the Notam with you ?) but apply to ALL approaches... Even an ILS
- Don't change the Altimeter Setting from what is on the ATIS.... These additives are "added" to the shown numbers on the charts
- Buy a new, EASy II Falcon where Temperature Comp is a simple button push....

  or, bring a calculator and some paper to look up the additives....
- Stay warm (and safe) out there .....

QUESTIONS ?