National Transportation
Safety Board

Memorandum

Date: March 5, 2013

To: Shawn Etcher
Air Safety Investigator, Eastern Regional Office (Miami)

From: John O'Callaghan
National Resource Specialist – Aircraft Performance

Subject: Performance plots for ERA12FA567

Shawn:

Attached please find performance plots for the Beechjet 400 (N428JD) accident in Macon, Georgia (KMAC) on September 18, 2012 (ERA12FA67). The performance parameters presented are based on:

- The MCN Airport Surveillance Radar (ASR) returns for N428JD at KMAC on 9/18/2012, as provided by Dan Bartlett
- The KMCN METAR at 13:53Z (KMCN is 8.75 nmi on a 210° true bearing from KMAC)
- Wind data provided by Mike Richards
- "Landing Distance – Wet or Compacted Snow" graph on page 23 of 62 of the Beechjet 400 AFM Supplement for Operation on Wet or Contaminated Runways

The plots of radar data and radar-derived parameters are based on the beacon code 1200 returns from N428JD only, since the airplane switched to this code early enough in the approach to capture the portion of the flight that is of interest while on that code.

Given the nature of the accident (overrun of runway 28 on landing), it is of interest to ascertain both the expected performance of the airplane given the environmental conditions and airplane performance information provided by the manufacturer in the Airplane Flight Manual (AFM) and its supplements; and, if possible, whether the airplane in fact performed as expected.

The landing distances published in the AFM supplement assume the airplane is 50 ft. high and at Vref when it crosses the runway threshold. Higher heights above the runway, or speeds faster than Vref, can result in a "long" landing and longer landing distances. A steep approach (flight path above PAPI 3° glide slope) can result in excessive height over the threshold, faster than nominal approach speeds, or both. Care must be taken when using radar data to consider these questions, as there is some uncertainty associated with both the radar data and the wind data (see below). Nonetheless, it seems that while the data does not indicate that the landing was long (in fact, it appears the airplane arrived at the threshold either at or below the PAPI glideslope), it may have been 15 to 19 knots fast relative to a reference speed of 110 knots.[1] The airplane appears to have aligned with the runway about 1.25 nmi from the threshold, and flew an approach from this point steeper than the nominal 3° glide slope (i.e., closer to 4°). Speed appears to be decreasing throughout, and appears to be in the range of 125 to 129 knots over the threshold, which is faster than the nominal approach speed of Vref + 10 knots of 120 knots, decreasing to Vref (110 knots) over the threshold. However, uncertainty in the winds makes it risky to depend totally on these computed airspeeds.

While the radar data suggests that the approach was flown both steeper and faster than nominal, it is important to note that the nominal landing distance on a wet runway specified by the AFM supplement for the conditions of the accident flight exceeds the runway length. Consequently, even if the approach had been flown perfectly, the AFM supplement data indicates that the airplane could not have been stopped on the pavement. However, had the approach speed been closer to nominal, the speed of departure off the end of the runway would likely have been lower. Unfortunately, there is insufficient information available about both (1) the actual conduct of the landing and rollout (including the timing and use of brakes, spoilers, and thrust reversers), and (2) the details regarding airplane's deceleration performance on a wet runway as a function of these variables, with which to quantify the effects of the touchdown speed and location on the departure speed off the end of the runway.

Approach performance based on radar data

There is uncertainty in the radar Mode C altitude data both because the data is rounded to the nearest 100 ft., and because the altimeter setting correction in the radar data file may be stale or otherwise incorrect. The ASR file contains both Mode C pressure altitude, and a "corrected" altitude to account for the altimeter setting. In the file, the "corrected" altitudes are 200 ft. lower than the pressure altitudes, putting the last two returns from N428JD at 300 ft.. However, the threshold elevation of runway 28 is 412 ft., and clearly the airplane can't be lower than the threshold elevation. Further, the altimeter setting from the KMCN METAR is 29.77 "Hg, which equates to about a -139 ft. correction to pressure altitude (not 200 ft.). As presented in Figures 2 and 3, I estimated the airplane's true altitude by subtracting 139 ft. from the Mode C pressure altitude, and then drawing +/- 50 ft. uncertainty bands around the results. These uncertainty bands are also shown in the plots.

Uncertainty in both the radar position and altitude results in unrealistic "noise" when computing speeds and rates of climb. To compensate for this, I've "smoothed" the radar data, while ensuring that the smoothed results remain within the radar position and Mode C uncertainty bands (the uncertainty boxes for position are shown in the plan view of the approach). The smoothed altitude data still resulted in the last two points being below the runway threshold, so I also generated a solution where these points are "constrained" to the runway elevation. The constrained points just fit under the upper Mode C uncertainty band. The altitudes and rates of climb based on these "constrained" points are labeled in Figures 2 and 3 as the "smoothed and constrained" lines.

[1] The Captain stated in his interview that "ten or eleven miles from the airport, current altimeters were set, [the First Officer] had already told me that my landing weight was thirteen five, gonna be a 108 ref speed." However, per the chart shown in Figure 7a, the actual reference speed at a weight of 13,500 lb. is 110 knots.

I know that at the time of the accident the PAPI was inoperative, but to compare the approach to the nominal 3° glide slope that would have been provided by a working PAPI, I drew in the 3° glide slope on the profile view of the approach, along with lines indicating where the PAPI lights would change color. The corresponding PAPI light presentation (red or white) is shown at the top of Figure 2.

Bearing the uncertainties noted above in mind, here are some observations on the results:

- The airplane appears to have lined up on the extended runway centerline and runway heading at about 14:02:40 UTC, at an altitude of 900 ft. MSL (488 ft. AGL), and about 1.25 nmi from the threshold (see Figures 1 and 5).
- The rate of descent was about 400 ft./min until about 14:02:05 (1340 ft. MSL), when it started to increase, reaching -1000 ft./min at 14:02:30 (1060 ft. MSL, 648 ft. AGL). The flight path angle likewise steepened between these points, from about -2° to about -4° (see Figure 4).
- The rate of descent remained at about -1000 ft./min until about 14:02:53 (700 ft. MSL, 288 ft. AGL, 0.7 nmi from the threshold), when it decreased steadily as the airplane approached touchdown (Figure 4).
- The altitude calculation shows the airplane initially somewhat high on the approach, but because of the steeper than nominal flight path angle (-4° vs. -3°), the airplane passes through the nominal glide slope and appears at or below the glide slope at the runway threshold. Hence, the calculation does not indicate that the approach was high crossing the threshold, though the data does not provide any information about actual touchdown location (see Figure 2).
- When the airplane lined up with the runway at 14:02:40, the calibrated airspeed was decreasing through about 138 knots (see Figure 4).
- At 14:02:50, the calibrated airspeed was about 137 knots, and started to decrease at a faster rate (Figure 4).
- At 14:03:08 (480 ft. MSL, 68 ft. AGL), the airspeed calculation is at its lowest value (125 knots) and appears to indicate a leveling of the speed in the range of 125 to 129 knots throughout the remainder of the calculation (Figure 4). Again, because of the uncertainty in the winds, there is also uncertainty in the airspeed calculation; a higher headwind will increase the actual airspeed, while a higher tailwind will decrease the actual airspeed (the assumed winds are plotted in Figure 6).

Landing distance based on AFM supplement

As noted above, the Beechjet 400 AFM contains a supplement for computing takeoff and landing performance on wet and contaminated runways. The graph titled "Landing Distance – Wet or Compacted Snow" on page 23 of the supplement can be used to determine the landing distance on a wet, ungrooved runway. Figure 7a shows a copy of this graph, and Figure 7b shows an expanded copy with red lines indicating the computation of the landing distance based on the following inputs:

- Pressure altitude = 551 ft. (412 ft. field elevation at an altimeter setting of 29.77 "Hg, adjusted to standard pressure of 29.92 "Hg). (Approximated as 500 ft. in Figure 7.)
- OAT = 22° C
- Weight = 13500 lb.
- Headwind = 4 kt.
- Runway slope = 0.4% downhill

The results in Figure 7b show a required landing distance of a little over 4800 ft. for an approach speed at Vref, and a landing distance of about 6100 ft. at an approach speed of Vref + 10 knots. Runway 28 at KMAC is 4694 ft. long, and so the required landing distance (even at Vref) exceeds the runway length.

Please write or call with any questions about these calculations, the radar data, or the plots.

Regards,

John O'Callaghan

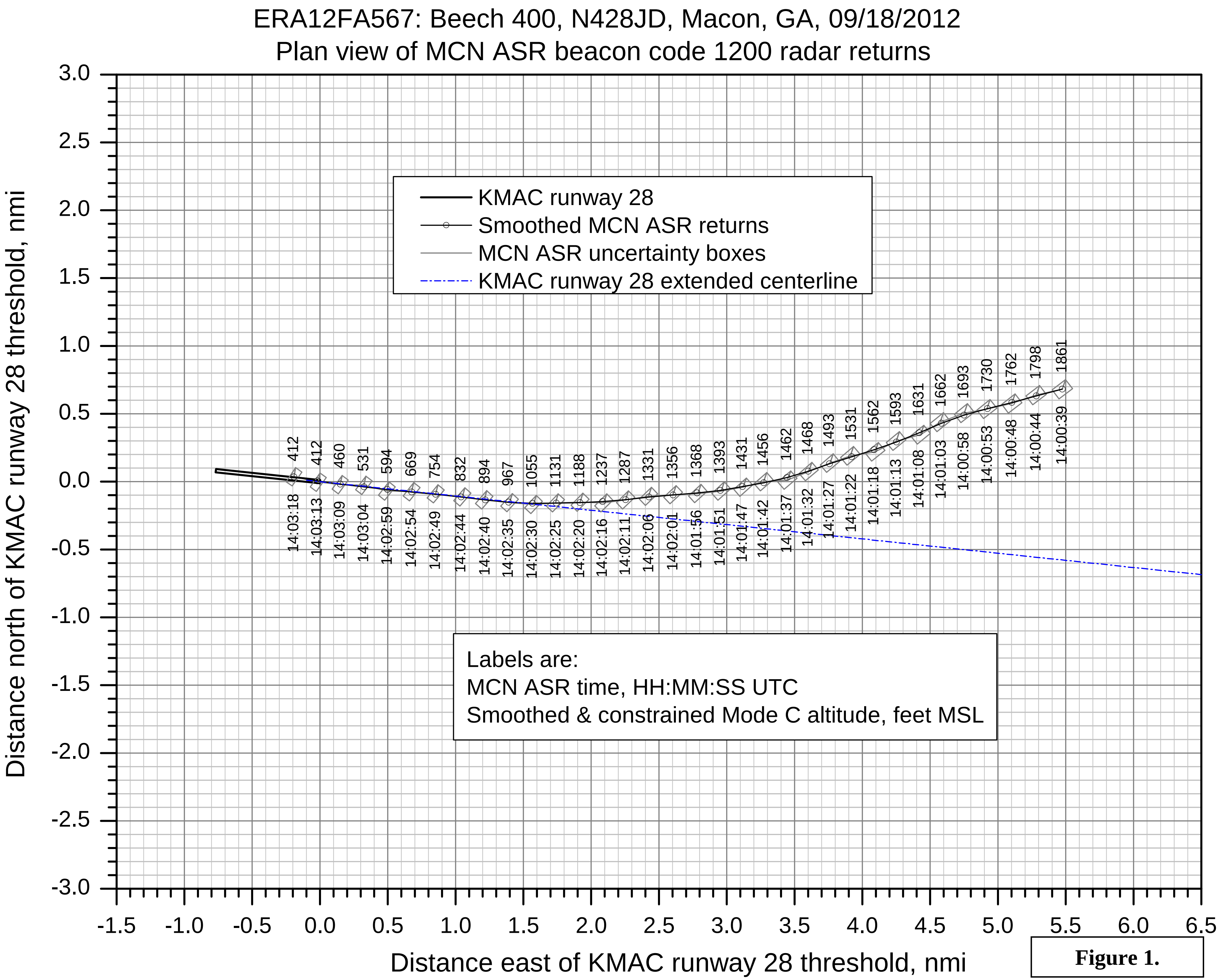

ERA12FA567: Beech 400, N428JD, Macon, GA, 09/18/2012
Plan view of MCN ASR beacon code 1200 radar returns
KMAC runway 28
Smoothed MCN ASR returns
MCN ASR uncertainty boxes
KMAC runway 28 extended centerline
Labels are:
MCN ASR time, HH:MM:SS UTC
Smoothed & constrained Mode C altitude, feet MSL
Distance north of KMAC runway 28 threshold, nmi
Distance east of KMAC runway 28 threshold, nmi
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
412
412
460
531
594
669
754
832
894
967
1055
1131
1188
1237
1287
1331
1356
1368
1393
1431
1456
1462
1468
1493
1531
1562
1593
1631
1662
1693
1730
1762
1798
1861
14:03:18
14:03:13
14:03:09
14:03:04
14:02:59
14:02:54
14:02:49
14:02:44
14:02:40
14:02:35
14:02:30
14:02:25
14:02:20
14:02:16
14:02:11
14:02:06
14:02:01
14:01:56
14:01:51
14:01:47
14:01:42
14:01:37
14:01:32
14:01:27
14:01:22
14:01:18
14:01:13
14:01:08
14:01:03
14:00:58
14:00:53
14:00:48
14:00:44
14:00:39

Figure 1.

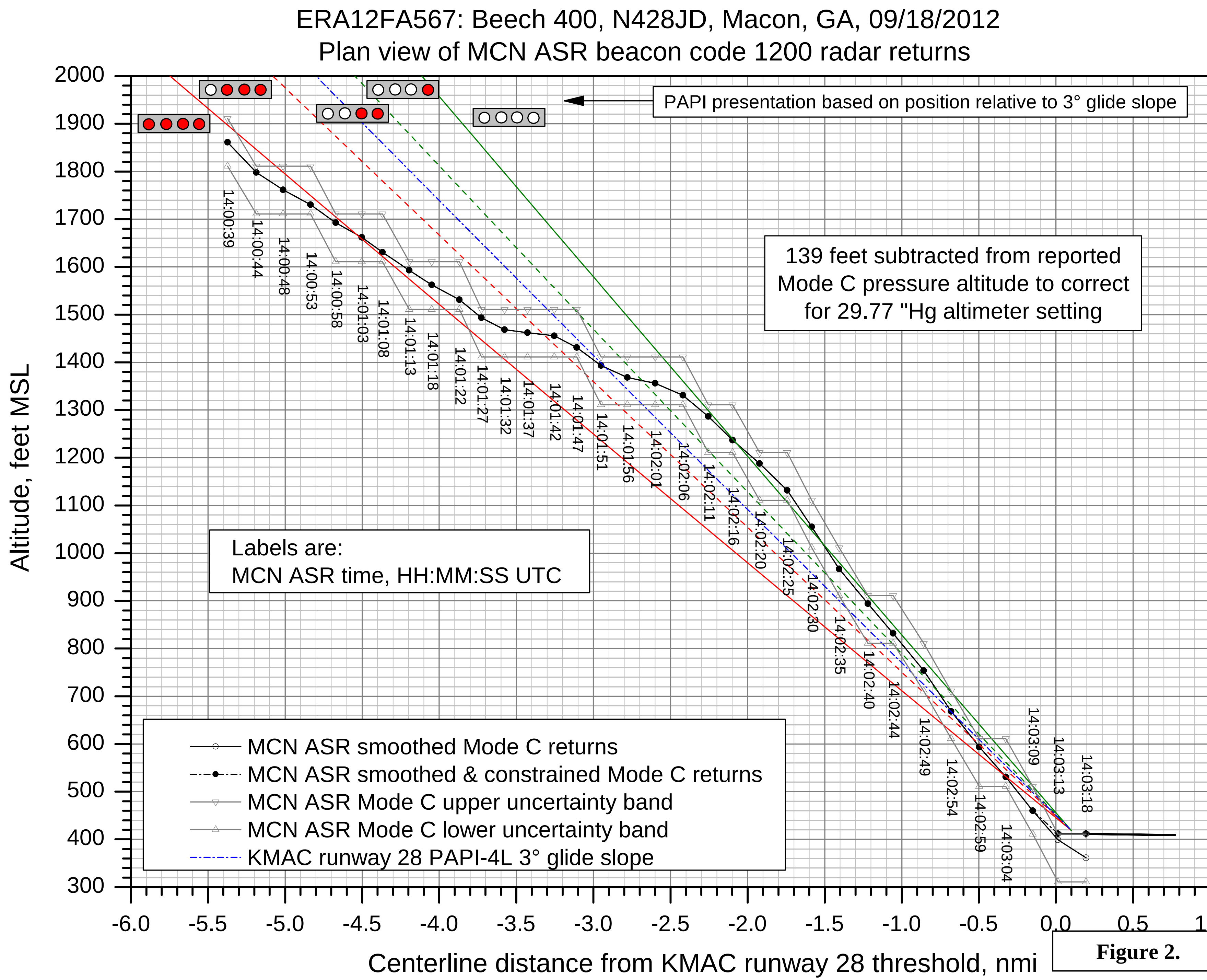

ERA12FA567: Beech 400, N428JD, Macon, GA, 09/18/2012
Plan view of MCN ASR beacon code 1200 radar returns
PAPI presentation based on position relative to 3° glide slope
139 feet subtracted from reported Mode C pressure altitude to correct for 29.77 "Hg altimeter setting
Labels are:
MCN ASR time, HH:MM:SS UTC
MCN ASR smoothed Mode C returns
MCN ASR smoothed & constrained Mode C returns
MCN ASR Mode C upper uncertainty band
MCN ASR Mode C lower uncertainty band
KMAC runway 28 PAPI-4L 3° glide slope
Altitude, feet MSL
Centerline distance from KMAC runway 28 threshold, nmi

Figure 2.

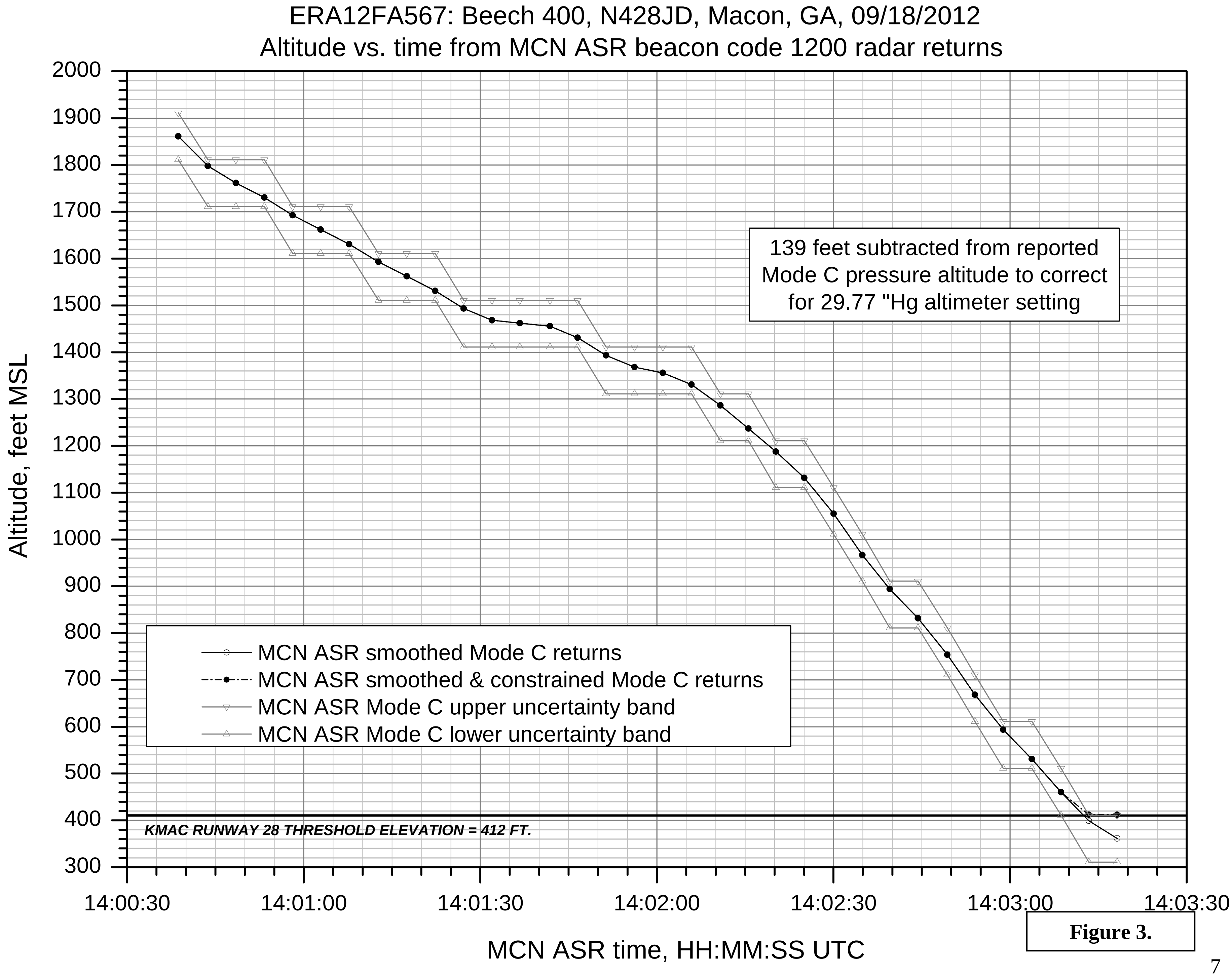
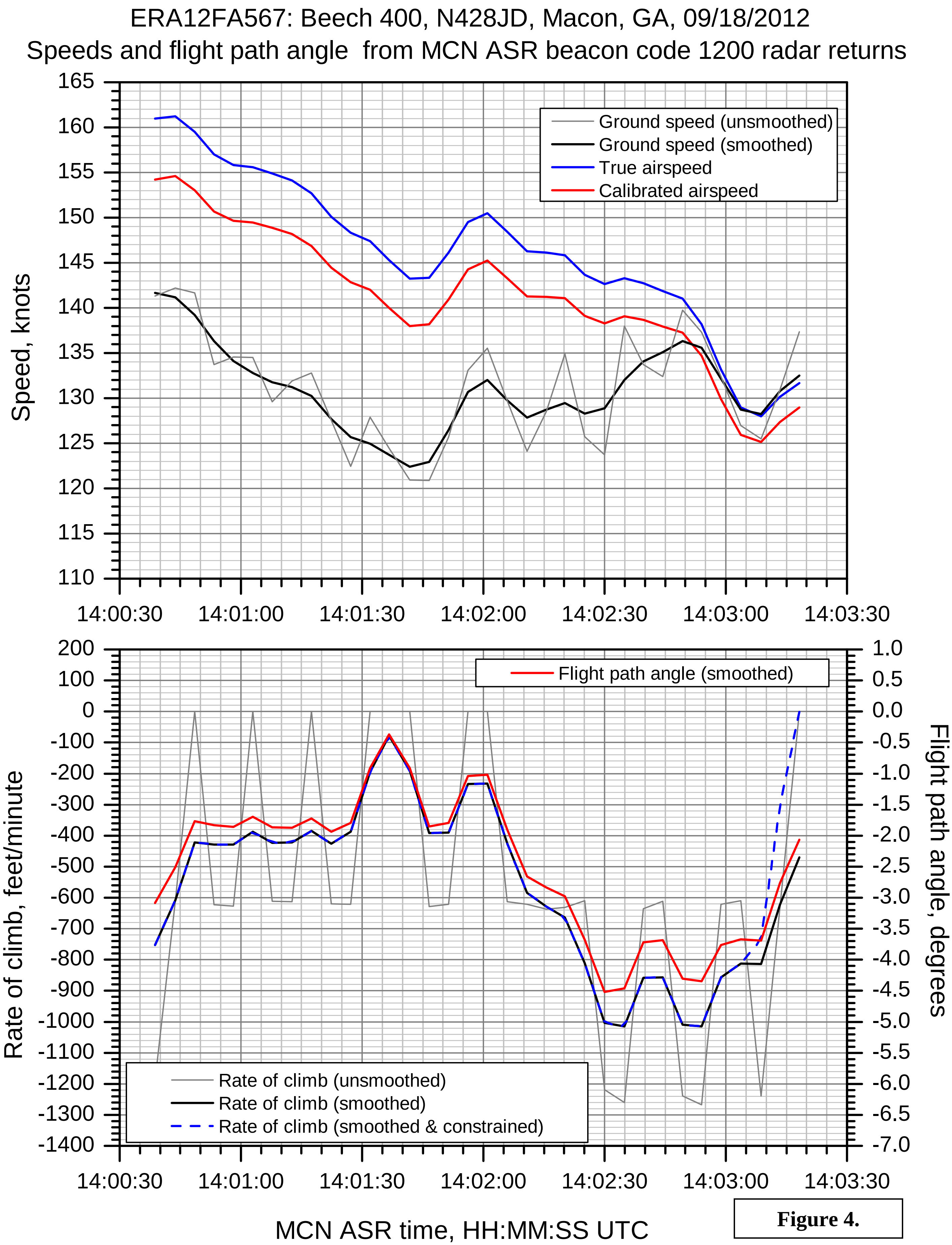
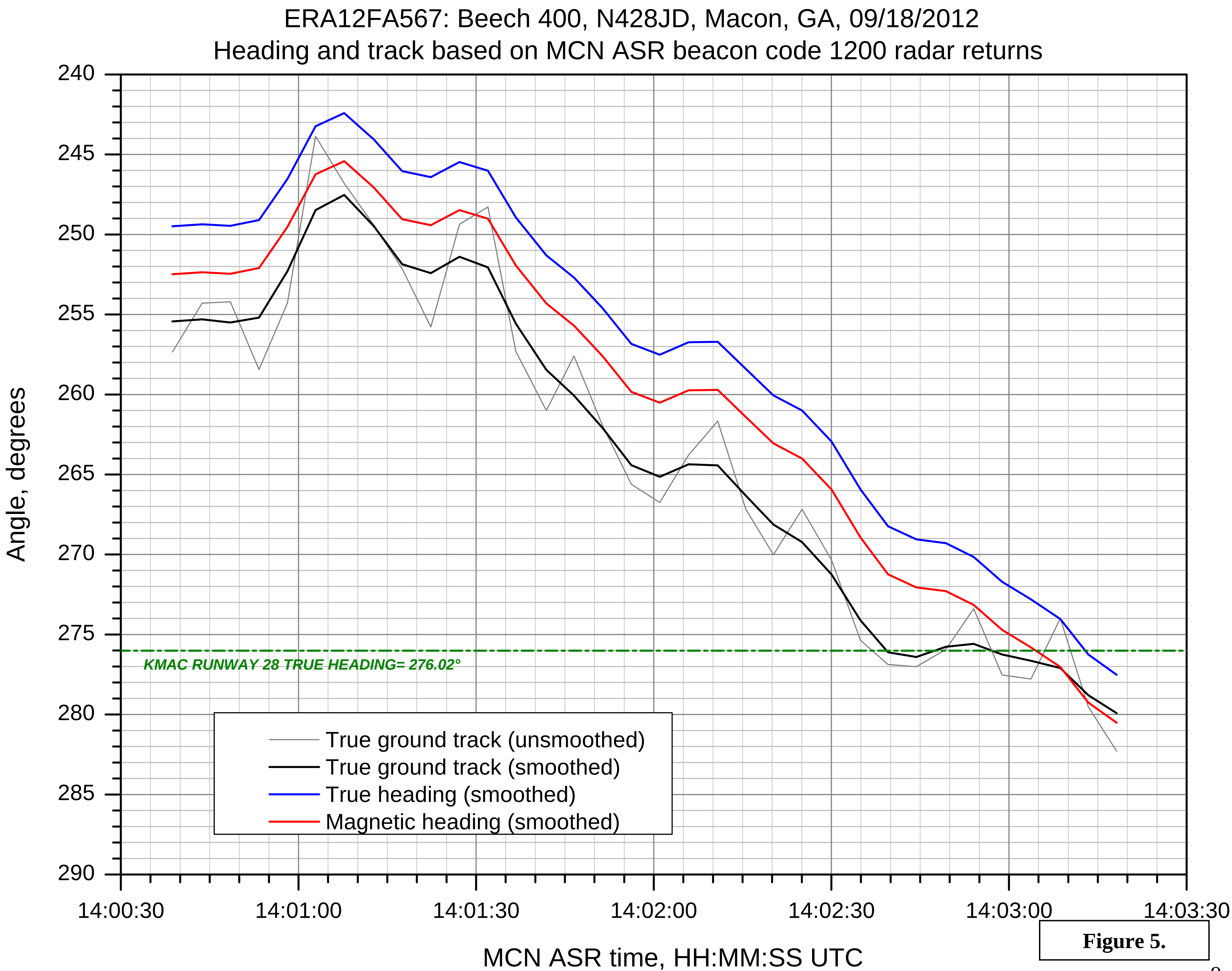

ERA12FA567: Beech 400, N428JD, Macon, GA, 09/18/2012
Altitude vs. time from MCN ASR beacon code 1200 radar returns
139 feet subtracted from reported Mode C pressure altitude to correct for 29.77 "Hg altimeter setting
MCN ASR smoothed Mode C returns
MCN ASR smoothed & constrained Mode C returns
MCN ASR Mode C upper uncertainty band
MCN ASR Mode C lower uncertainty band
KMAC RUNWAY 28 THRESHOLD ELEVATION = 412 FT.
Altitude, feet MSL
MCN ASR time, HH:MM:SS UTC
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
14:00:30
14:01:00
14:01:30
14:02:00
14:02:30
14:03:00
14:03:30

Figure 3.



ERA12FA567: Beech 400, N428JD, Macon, GA, 09/18/2012
Speeds and flight path angle from MCN ASR beacon code 1200 radar returns
Speed, knots
Ground speed (unsmoothed)
Ground speed (smoothed)
True airspeed
Calibrated airspeed
Flight path angle (smoothed)
Rate of climb, feet/minute
Flight path angle, degrees
Rate of climb (unsmoothed)
Rate of climb (smoothed)
Rate of climb (smoothed & constrained)
14:00:30
14:01:00
14:01:30
14:02:00
14:02:30
14:03:00
14:03:30
MCN ASR time, HH:MM:SS UTC

Figure 4.



ERA12FA567: Beech 400, N428JD, Macon, GA, 09/18/2012
Heading and track based on MCN ASR beacon code 1200 radar returns
Angle, degrees
240
245
250
255
260
265
270
275
280
285
290
KMAC RUNWAY 28 TRUE HEADING= 276.02°
True ground track (unsmoothed)
True ground track (smoothed)
True heading (smoothed)
Magnetic heading (smoothed)
14:00:30
14:01:00
14:01:30
14:02:00
14:02:30
14:03:00
14:03:30
MCN ASR time, HH:MM:SS UTC

Figure 5.

ERA12FA567: Beech 400, N428JD, Macon, GA, 09/18/2012
Assumed winds for speed calculations

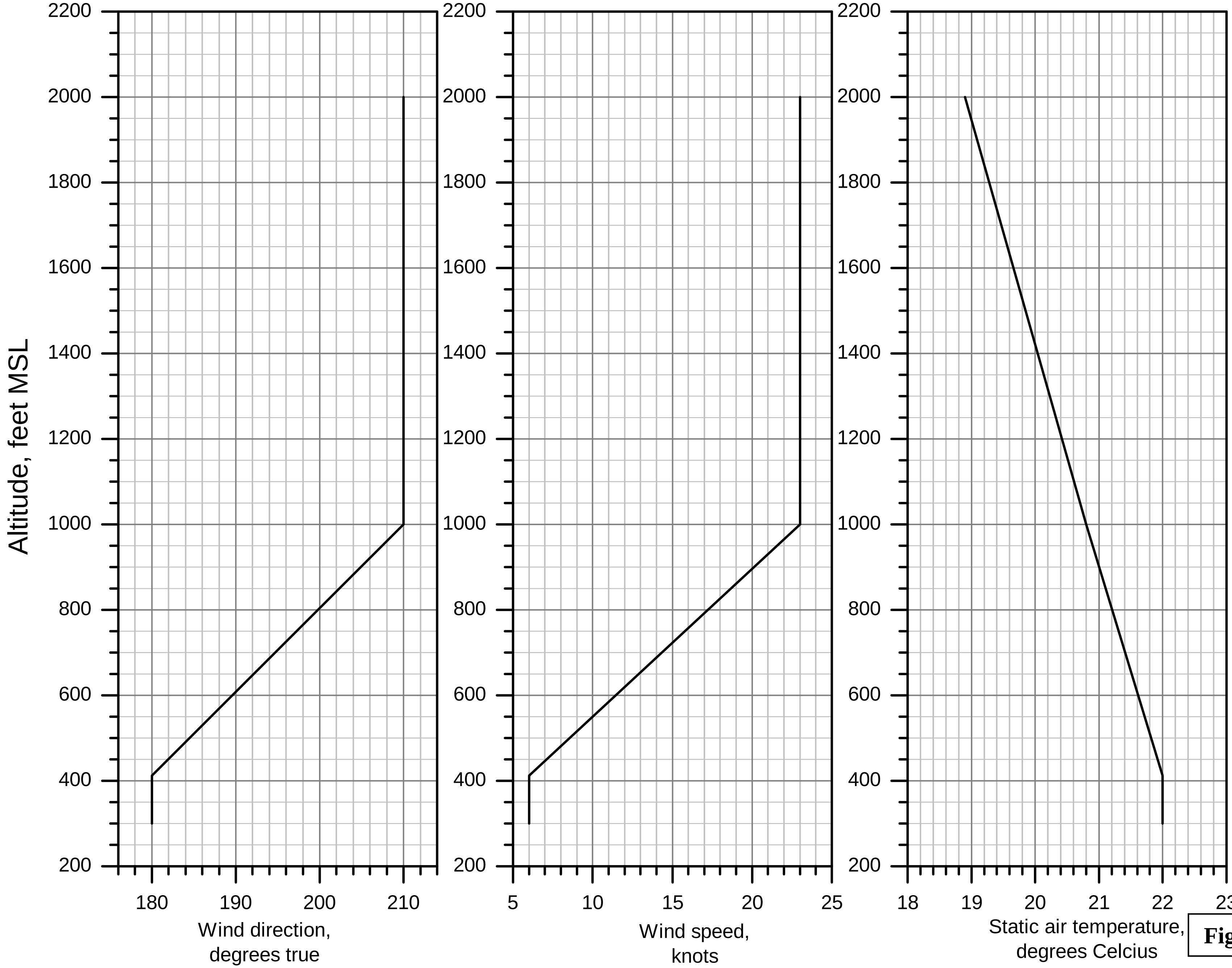


Figure 6.

LANDING DISTANCE
WET OR COMPACTED SNOW

ASSOCIATED CONDITIONS:

THRUST...........RETARD TO MAINTAIN 3-DEGREE APPROACH ANGLE TO 50 FT. AT 50 FT, RETARD TO IDLE.
ANTI-SKID........ON
APPROACH SPEED...V_{REF}
FLAPS............30°
BRAKING..........MAXIMUM

WEIGHT - POUNDS	V_{REF} - KNOTS
15,780	119
15,000	116
14,220	113
13,000	108
12,000	104
11,000	100
10,000	96

EXAMPLE:

OAT........................20°C
FIELD PRESSURE ALTITUDE...2000 FT
WEIGHT.....................13,000 LB
RUNWAY GRADIENT...........1% UP
HEADWIND COMPONENT........10 KT
V_{REF}......................108 KT

LANDING DISTANCE:

V_{REF}........................4403 FT
V_{REF} + 10 KT..............5587 FT

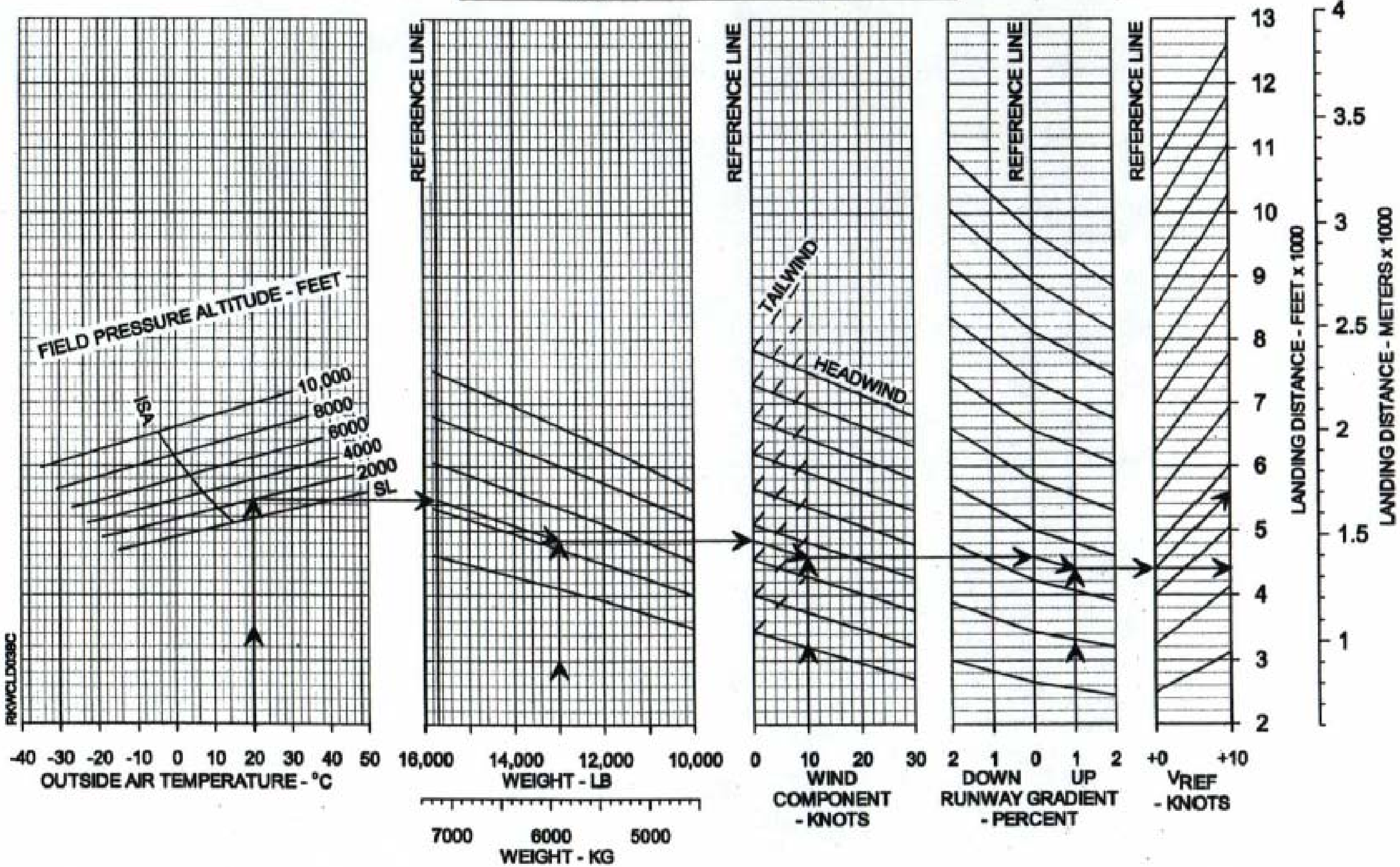


Figure 7a.

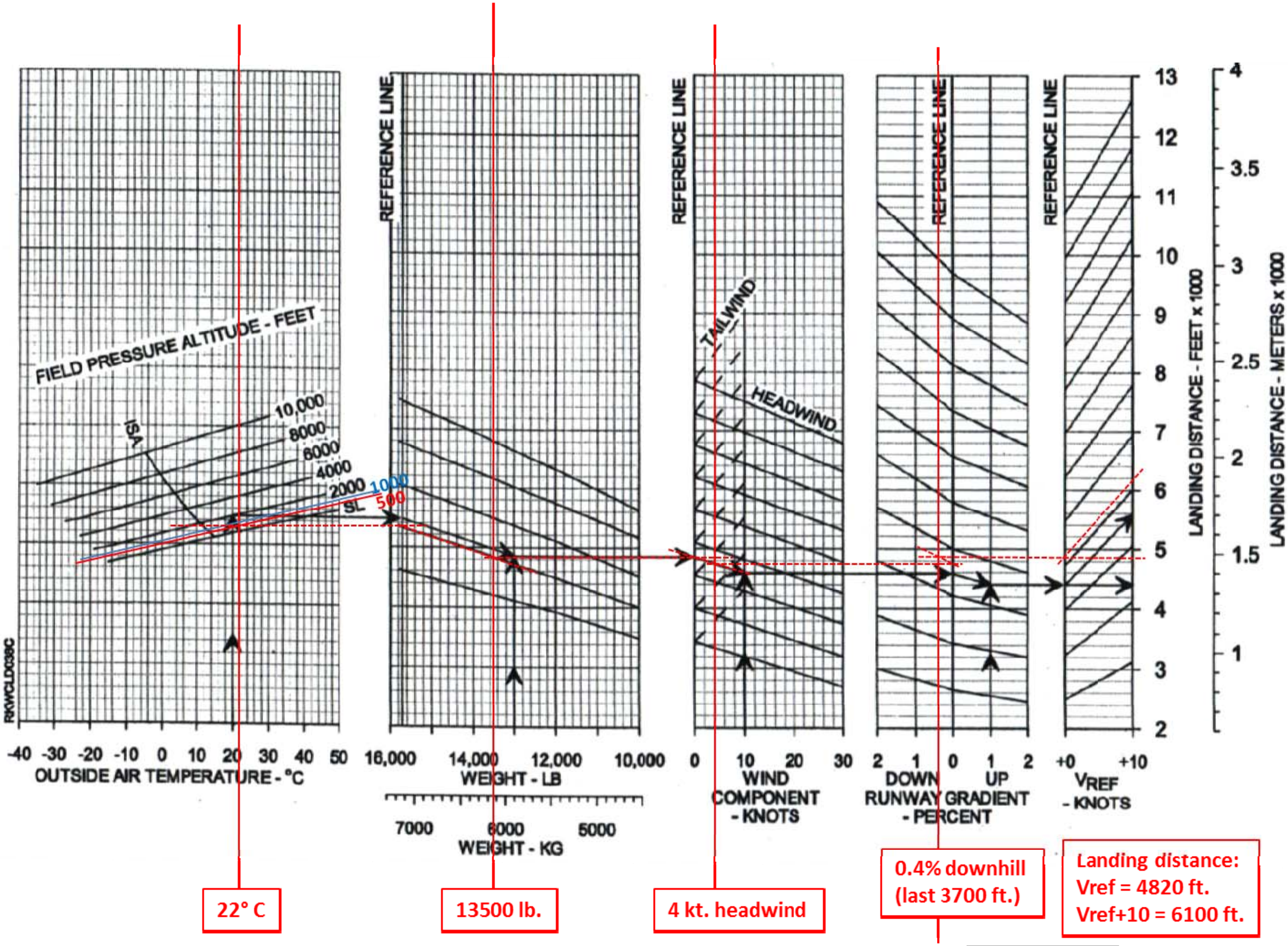

FIELD PRESSURE ALTITUDE - FEET
10,000
8000
6000
4000
2000
1000
500
SL
ISA
REFERENCE LINE
REFERENCE LINE
REFERENCE LINE
REFERENCE LINE
TAILWIND
HEADWIND
-40 -30 -20 -10 0 10 20 30 40 50
OUTSIDE AIR TEMPERATURE - °C
16,000 14,000 12,000 10,000
WEIGHT - LB
7000 6000 5000
WEIGHT - KG
0 10 20 30
WIND COMPONENT - KNOTS
2 1 0 1 2
DOWN UP
RUNWAY GRADIENT - PERCENT
+0 +10
VREF - KNOTS
13 12 11 10 9 8 7 6 5 4 3 2
LANDING DISTANCE - FEET x 1000
4 3.5 3 2.5 2 1.5 1
LANDING DISTANCE - METERS x 1000
RKWCLD039C
22° C
13500 lb.
4 kt. headwind
0.4% downhill
(last 3700 ft.)
Landing distance:
Vref = 4820 ft.
Vref+10 = 6100 ft.

Figure 7b.