

# CALLBACK

From NASA's Aviation Safety Reporting System



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## VNAV – Vertical Navigation Operations

Flight safety is, in large part, contingent upon an aircraft's separation from terrain and other aircraft. In today's world of crowded skies, reduced vertical separation, and automation during most phases of flight, Vertical Navigation (VNAV) operations are paramount, and aircrew discipline is crucial.

VNAV systems are intricate, requiring complex interactions with other aircraft automation and especially with aircrews. Operational modes can be confusing. Misunderstanding mode details or nuance, incorrectly programming, or mismanaging the VNAV can produce dangerous aircraft responses that are unexpected and unwanted by pilots.

This month *CALLBACK* shares incidents revealing VNAV complexity, the importance of VNAV discipline, and the short time it takes for problems to escalate and safety to deteriorate when VNAV discipline is compromised. Have you ever asked any of these questions of your VNAV?

### Part 91 – Why Did It Do That?

This corporate Hawker 750 First Officer (FO) shares what might appear to be a simple altitude deviation. The event and related factors both reveal some confusion and provide insight into mitigating the problem.

■ *While descending for the RNAV approach...we had a brief altitude excursion. I was the Pilot Monitoring (PM) and second in command for the flight. We were cleared for the RNAV via the VOR, [an assigned] fix, straight in, and told to maintain 7,500 feet to the VOR. As I was looking down programming the Flight Management System (FMS), I looked up and noticed that the Captain had descended below our altitude assignment of 7,500 feet and went as low as 7,100 feet as I recall. I called out the altitude immediately and asked the Captain why the VNAV had been turned off. At that same time, Approach advised us of a low altitude alert, and we were told to climb to 7,500 feet. We climbed back up to 7,500 feet and completed the approach with no other issues. At no time did ATC advise us of a pilot deviation, and they never asked us to call a phone number.*

*When flying RNAV approaches, our company procedure is to make sure all crossing restrictions are entered into the FMS and checked. If an altitude does not meet the crossing restriction, we enter the crossing restriction altitude for each assigned fix. Then we put the final approach fix altitude*

*in the altitude preselect [window] and use the VNAV button to descend and meet all crossing restrictions, while monitoring the pink altitude in the top right-hand corner of the PFD to make sure the airplane knows what altitude to descend to. This was an RNAV approach to LNAV/VNAV minimums, so we would select Approach mode after the airplane was within 30 degrees of the final approach course and established inbound for the approach. We followed this procedure for this approach, however, somehow the VNAV button got disengaged, which led to the airplane descending below our crossing altitude of 7,500 feet at the VOR.*

*The problem was compounded when I diverted my attention to the FMS and was not watching the Captain's autopilot selections or monitoring our altitude. The VNAV function was somehow disengaged. We descended toward the altitude selected in the altitude preselect. [There were several] contributing factors. Weather [was] in the area. Heavy rain shafts were all around the airport, and we were discussing whether to continue or request vectors away. I was programming the FMS and did not see the Captain descend below our altitude or press the VNAV button to disengage it. We were in IMC, and the published missed [approach] would have put us into the rain shafts, so we were discussing alternate missed approach procedures and relayed the request to ATC. We...also had some confusion about accepting the RNAV [approach] from the VOR [via] the assigned fix straight in, or just from the assigned fix straight in.... We had been given an altitude of 7,500 feet to maintain, instead of 8,100 feet like on the chart. Our pilots and other pilots are confused whether 7,500 feet is legal or...we would need to cross at 8,100 feet like stated on the chart.*

### Part 135 – Where Is the Missing Waypoint?

This fractional Learjet Captain describes quickly escalating confusion and difficulty in programming and executing an RNAV approach. A waypoint and its crossing restriction appear to be missing in the lateral and VNAV automation.

■ *A Learjet 60 descended below the MEA and intermediate fix crossing altitude on the RNAV (GPS) [approach]. Subsequently a go-around was issued by ATC, and the approach was flown again to a successful landing. We were originally issued a hold on the way to the airport;*

all airplanes requesting the RNAV (GPS) approach were issued holds. Another aircraft questioned how an airplane just landed and was told that the only airplanes getting in are flying the localizer approach. We then requested the localizer approach, and we set up and briefed the approach as published. As we were being vectored to join the localizer, we were then issued the RNAV (GPS) instead, a few miles from the VOR. After adjusting the FMS to now fly the GPS approach, we crossed the VOR at 13,000 feet and started the approach. The fixes in the FMS were as follows: VOR [Fix 1], and [Fix 3]. Missing from this approach in the FMS is the intermediate fix [Fix 2] that has a crossing altitude of 12,900 feet. Not seeing this fix in the FMS and having previously briefed a different approach with little time to set up and brief a completely different approach, we proceeded down to the final approach fix altitude of 12,200 feet at [Fix 3]. Upon leveling off, we were given a low altitude alert from ATC stating the MEA in that sector is 13,000 feet. This was the first indication on the [flight deck] that something wasn't right.... We immediately started a climb. We were then told that [Fix 2] has a crossing restriction of 12,900 feet. After slight confusion on the [flight deck] for a second of "what fix?" a go-around was initiated. Not even two seconds after that, a go-around was issued by ATC. The go-around was flown as published and the approach was then again initiated and flown to a successful landing. Further exacerbating the situation was the FMS not recognizing the approach as an approach, but simply waypoints... so the VNAV was not usable for the approach. To avoid a similar situation, care should be given when accepting a new approach so close to the initial approach fix when a different approach had been set up and briefed. Further verification of any intermediate fixes and crossing altitudes, not just the initial and final, would have helped had time permitted.

## Part 121 – What's It Doing Now?

A B767 Captain details the consequences of the crew's VNAV interactions. The Relief Pilot further reveals some sobering insight and explores the gravity of the situation.

From the Captain's report:

■ We began the approach, but updated weather indicated the airport was below minimums, so we coordinated to hold. While in holding, [Company] advised that another flight landed successfully, and with updated weather, we had the visibility required to begin the approach. ATC amended our holding altitude from 5,000 feet to 7,000 feet, but we forgot to put our new cruise altitude in the Flight Management Computer (FMC) like we did before attempting the first approach. We received vectors to intercept the final

approach course and commenced the approach but did not recognize our lack of vertical guidance due to not entering a new cruise altitude. The aircraft appeared to be flying the approach in LNAV/VNAV passing the final approach point, but began a descent rate approaching 1,500 fpm that wasn't recognized. The Relief Pilot and Pilot Flying (PF) began looking for approach lights as we approached minimums. They had the approach lights in sight, and so we continued the approach, still descending faster than planned. All of us were looking for the runway environment. At about the same time the PF and Relief Pilot saw 4 reds on the PAPI, we received an EGPWS terrain warning. I incorrectly called for a go-around instead of a CFIT (Controlled Flight into Terrain) recovery, and during the maneuver, the pitch attitude became excessive and we received a low airspeed caution as it decreased to around 105 knots. We completed the maneuver, sorted through the distraction of low fuel cautions due to our 10,000 pounds of fuel sloshing during the go-around, and diverted to a nearby airport.

From the Relief Pilot's report:

■ Following holding, the crew flew an RNAV [approach]. The crew made common errors on the approach and ultimately descended inappropriately below the minimum descent altitude using faulty visual cues.... The subsequent go-around resulted in a "Caution Terrain" and then "Whoop-Whoop, PULL-UP." ... The descent had inadvertently been continued during the go-around, which caused the GPWS caution/warning. Then, the crew misapplied established procedures on the... go-around, which resulted in excessively slow airspeed. I had to intervene during both the RNAV approach and subsequent go-around to ensure safety. The crew should have realized there was not a proper vertical path and either modified [the] descent rate or discontinued the approach. Also, the crew should have had the situational awareness to know that they were still several miles from the approximate visual descent point and use that information when deciding to proceed below the MDA. During the go-around, the FO became task saturated with non-critical items (FMS, ATC communication, etc.) and failed to monitor the flight path adequately and perform PM duties correctly. This greatly affected the safety of flight during the go-around.



## NASA ASRS UAS Safety Reporting

Anyone involved in UAS operations can file a NASA ASRS report to describe close calls, hazards, violations, and safety related incidents.

ASRS Alerts Issued in April 2024	
Subject of Alert	No. of Alerts
Aircraft or Aircraft Equipment	4
Airport Facility or Procedure	8
ATC Equipment or Procedure	14
Other	1
<b>TOTAL</b>	<b>27</b>

533  
A Monthly Safety  
Newsletter from  
**The NASA**  
Aviation Safety  
Reporting System  
P.O. Box 189  
Moffett Field, CA  
94035-0189  
<https://asrs.arc.nasa.gov>

April 2024 Report Intake	
Air Carrier/Air Taxi Pilots	6,770
Flight Attendants	1,802
General Aviation Pilots	1,595
Military/Other	904
Mechanics	354
Controllers	313
Dispatchers	305
<b>TOTAL</b>	<b>12,043</b>