# AERONAUTICAL CHARTING FORUM
## Instrument Procedures Group
### Meeting 17-02 – October 24, 2017

**RECOMMENDATION DOCUMENT**

**FAA Control # 17-02-330**

**Subject:** Climb gradients for Standard Instrument Departures (SIDs)

**Background/Discussion:** Area navigation (RNAV) SID development now includes required Air Traffic Control (ATC) crossing restrictions to separate traffic and ATC has clearly articulated compliance with these altitudes are not optional. In every RNAV SID development process, the SRM defines all published altitudes must be met to ensure safe separation of traffic but recent changes to FAA orders has removed important climb gradient information needed by the pilot to determine performance requirements.

Recently, Order 8260.46F, Establishing Submission Cutoff Dates for Civil Instrument Flight Procedures, was amended deleting two critical sets of information for both designers and pilots. Charting of climb gradients for ATC restrictions are an important safety factor for pilots. Removing the requirement for a Flight Standards' review of ATC climb gradients in excess of 500 ft/NM has allowed new SIDs to be introduced into the National Airspace System (NAS) with unrealistic climb gradients. Additionally, the lack of a charted climb gradient to comply with ATC altitude restrictions has proven to be extremely problematic for pilots.

FAA design criteria mandates and Flight Standards review of any climb gradient in excess of 500 ft/NM except those used to support airspace, navigation solutions, environmental, or ATC operational limitations. For pilots, having a charted climb gradient for ATC restrictions is a necessary component to determine if their flights can meet the performance requirements to fly the departure as charted.

The FAA has published the following text in Order 8260.46F:

Pilots are expected to determine if crossing altitudes can be met, based on the performance capability of the aircraft they are operating.

This statement coupled with uncharted climb gradients could not pass an safety risk management (SRM) process. How can a pilot determine if an altitude restriction can be met if there is no published information?

**Recommendations:**

1. As defined for diverse vector area (DVA) and obstacle climb gradients, establish a requirement for Flight Standards to review any climb gradient in excess of 500 ft/NM.

2. Establish a collaborative check and balance system that allows users of the NAS to make input on climb gradients.

3. Revise the text in Order 8260.46F, Departure Procedure (DP) Program, to

include a statement that altitude restrictions in SIDs **do** constitute climb gradients for the safe separation of traffic.

4. Re-establish criteria that will evaluate climb gradients for SIDs using the procedure as a template. When possible establish one published climb gradient that gives the pilot the ability to determine if the procedure can be flown as designed. When maximum or mandatory altitude restrictions are published additional climb gradients must be established to aid the pilot with determine performance requirements for that segment of the procedure.

**Comments:** Southwest Airlines has conducted an SRM on ATC climb gradients and determined the pilot cannot comply with charted restrictions unless a known climb gradient requirement is published.

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**Date:** October 5, 2017

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**INITIAL DISCUSSION – MEETING 17-02:** Gary McMullen (Southwest Airlines) briefed (views) an issue related to the difficulty of pilots being able to determine if published crossing altitude restrictions on SIDs can be met when an associated climb gradient (CG) isn't published. Gary stated pilots are expected to meet all restrictions on a SID; however, without a published climb gradient, pilots don't have enough information available to them to ensure they are able to meet crossing restrictions. Gary indicated that unlike STAR, there is no VNAV path available to a departing aircraft, and that the pilots are using speed and thrust settings to climb to their assigned altitude. Gary stated that pilots understand climb gradients and can determine if they can or cannot meet a properly charted climb gradient; however, the FAA doesn't allow ATC climb gradients to be charted. Gary showed two example SIDs, the EMMTT 4 from Dallas Love and the TERPZ 6 from Baltimore. He explained these SIDs included crossing restrictions that were not flyable without using additional thrust, which is something they can't do on a daily basis. Gary stated some recommendations, to include the reversion of policy to require the publication of ATC related climb gradients on SIDs. John Bordy (Flight Procedure Standards Branch) said a similar issue was submitted to the PARC Navigation Working Group in 2015 and asked if there was any progress. Gary said the issue was a very low PARC priority; he sees no way to elevate it so brought issue back to ACF for action. Al Herndon (MITRE) said when the PARC VNAV action team was incorporated into the PARC Navigation Working Group, this issue was not included so it doesn't exist in the PARC anymore. Gary recommended convening a working group to discuss the issue and develop a resolution, adding there are other smaller related issues that can be looked at. Rich Boll (NBAA) stated that the NBAA agrees with Gary's proposals; however, they are concerned with having only one climb gradient designed to meet every case since there is a large diversity of NBAA member aircraft. Rich then briefed (views) the NBAA views on this issue, and in particular the difficulty of defining what a climb gradient really is. He discussed how there's no clear definition of a flight path in a takeoff phase other than an engine-out scenario, and; therefore, no data is

available to the pilot for all engines operating. Rich discussed how it's possible to meet charted altitude restrictions; however, it's also possible for the aircraft to occasionally dip below the vertical plane associated with a climb gradient during certain climb segments. Rich stated aircraft can normally determine compliance in staying above the plane associated with a climb gradient at altitudes 1500-3000 feet above the airport elevation; however, it becomes more difficult at higher altitudes. Rich stated airlines have performance engineers that can determine if SIDs are compatible with their operations; however, the NBAA members do not have the same capability and tools available to them. Rich recommend proposals to add AIM language to clearly define what a climb gradient is for both obstacle and ATC driven climb gradients. NBAA also proposes either allowing a single, all-encompassing climb gradient on a SID (but open to multiple climb gradients). Rich also agreed with Gary that we are putting restrictions on procedures that can't be met and so some method to objectively evaluate high climb gradients, or gradients at higher altitudes needs to be developed. Bruce McGray (Flight Operations Branch) said technical data may be necessary to make recommendations related to crossing restrictions and climb gradients. John Bordy asked if the ACF is the correct forum to address these issues and pointed out that a few years ago it was determined that it wasn't, therefore it was referred to the PARC. However, since the PARC isn't working the issue, we've gone full circle in considering this issue once again for the ACF. Rich stated this issue related to Order 8260.46; therefore, a TERPS issue, and therefore the ACF is the appropriate forum. Gary and Rich agreed to co-chair an ACF-IPG working group to address this issue. A signup sheet (roster) to participate in this working group was established. Please contact Gary or Rich to join the working group.

**Action:** Gary McMullen (SWA) and Rich Boll (NBAA) will co-chair an ACF-IPG working group on the issue.

**Status:** Item accepted.

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**Meeting 18-01:** Rich Boll (NBAA) briefed from a slide presentation the findings of a working group he co-chaired with Gary McMullin over the past several months. The first part was asking the FAA to require approval before publishing any ATC crossing altitude restriction that would require a climb gradient of more than 500 ft/NM. Rich mentioned this request has already been accepted and is currently included within the draft Order 8260.46G that is currently being coordinated. The main proposal would be to reintroduce the publication of climb gradients for ATC purposes. Rich gave a brief overview of history (view) on publishing ATC and obstacle climb gradients (a previous ACF agenda item requested only publishing one gradient.) Rich informed the group that the FAA used to publish ATC climb gradients, but then ceased charting ATC climb gradients under the belief that they can be too onerous since they are calculated on a worst-case basis. Rich indicated climb gradient information is needed to help pilots determine whether a crossing altitude restriction can be met. The proposal is to once again chart ATC climb gradients on SIDs. Chart examples were shown and discussed. Rich said the working group's consensus is to establish a single climb gradient for obstacle clearance on SIDs and ODPs, and to annotate these as obstacle climb gradients. When ATC crossing altitude restrictions require a climb gradient on a SID, it is proposed to establish a single climb gradient that would allow compliance with all ATC restrictions. These climb gradients would be

identified on the chart as ATC climb gradients. Rich explained how the aircrew should treat each climb gradient differently. An obstacle climb gradient should be treated as a plane that the aircraft cannot ever penetrate from above, that is, the aircraft must always remain above the climb gradient's surface. Conversely, an ATC climb gradient only represents the average gradient needed to meet the crossing restriction at the fix where it's established. In this case, the aircraft's altitude between the point where the climb starts and the point where the altitude restriction is established is not that important, provided the crossing is made at the fix at (or above) the minimum charted altitude. The purpose of the ATC climb gradient is to inform the pilot of the necessary performance needed to comply with the altitude restriction. The working group suggested that a SID should be limited to one obstacle climb gradient, and if necessary, one ATC climb gradient. Further, an ATC climb gradient and the associated crossing restrictions should be eligible for cancellation by ATC when not needed or when aircraft performance is limited. Rich indicated that if the proposal is accepted, then requisite guidance and information must be published in the AIM, Aeronautical Information Publication, IPH, and Instrument Flying Handbook. Rich mentioned we already allow two climb gradients now, one for obstacles and one for LNAV engagement (when an early turn is necessary). For consideration, he suggested the possibility of establishing an assumption (through applicable guidance) that a 500 ft/NM climb gradient up to 500 feet above departure end of runway elevation be considered the norm, which would then negate the need to publish an LNAV engagement climb gradient (similar to our current 200 ft/NM assumption). Rich said this will have to go to the US-IFPP, but wanted ACF consensus prior. Rune Duke said AOPA supports this.

**Action:**

- Presentation (slide #31) is posted on the ACF web site for comment (request comments be directed to Rich Boll).
- John Bordy will introduce the topic to the June US-IFPP meeting for consideration.

**Status:** Item open.

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**Meeting 18-02:** John Bordy (Flight Procedures and Airspace Group) informed the group that this issue was referred to the US-IFPP for consideration and was discussed within the IFPP's Departure Working Group (DWG), which is being led by Dan Wacker (Flight Procedures and Airspace Group). Rich Boll (NBAA) added he recently discussed with Dan Wacker the three specific recommendations that were put forth. The first would be to "standardize" the 500 ft/NM climb gradient for LNAV engagement. However, Dan indicated to him there was no initial support from the DWG to accept this recommendation. The second recommendation to add ATC climb gradients did not garner much support either; however, the DWG recognized there is a potential problem with adding onerous altitude restrictions near the departure airport. The third recommendation to require Flight Standards approval to establish any ATC crossing altitude restriction that would require a climb gradient in excess of 500 ft/NM was accepted and will be published in FAA Order 8260.46G. Rich mentioned that Dan was planning to invite industry to an upcoming meeting of the DWG where they could express any concerns/suggestions related to this issue or any other SID design issue. John requested attendees of the IPG email him or Steve VanCamp if they would like to participate in that upcoming DWG.

**Action Items:** John Bordy to provide a status of the DWG actions related to this issue.

**Status:** Item open.

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**Meeting 19-01:** John Bordy, Flight Procedures and Airspace Group, briefed the issue directly from the slide: discussing a summary and current status. Recommendations from ACM WGs were referred to the US-IFPP Departure Working Group (DWG). The recommendation to calculate (but not publish) a climb gradient that would be required to meet an ATC crossing altitude restriction and to obtain AFS approval if more than 500 ft/NM was published within Order 8260.46G (published Nov 2018). The second part of the recommendation, which is to publish climb gradients necessary to meet ATC crossing altitude restrictions, is still actively being discussed within the DWG, and more information related to whether or not this recommendation will be accepted should be available by ACM meeting 19-02. Valerie Watson, AJV-A, asked what the specific objection is to charting a climb gradient. A lengthy discussion followed related to historical practices related to charting obstacle and ATC crossing restrictions, in addition to how the FAA currently publishes climb gradients, which as of now, is only done for obstacle clearance purposes (exception is for LNAV engagement to 500 ft AGL). Rich Boll, NBAA, questioned the adequacy of the 500 ft/NM value for determination of when FS approval is needed since he believes higher field elevations may dictate a lower value; John Bordy took an action to refer this to the DWG and to request the DWG consult with performance engineers on this issue.

**Action Items:**

- John Bordy will report on DWG progress on the issue.
- John Bordy will ask the DWG to consult with performance engineers to examine the 500 ft/NM value used for determining when FS approval is required. Concern is whether this is adequate for higher elevation airports.

**Status:** Item open.

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**Meeting 19-02:** John Bordy, FAA Flight Procedures and Airspace Group, briefed the issue summary and current status from the slide. The Departure Working Group (DWG) has been on hold while working on the safety risk assessment associated with the initial climb area (ICA) revision and reduction of obstacle notes. There is also an ongoing action to consult with performance engineers regarding the 500 ft/NM threshold at higher elevation airports. The aircraft performance engineers present at the meeting plan to have a break-out discussion on the issue and invited anyone who wanted to attend. They may also have a follow-up meeting in November to discuss that topic, and also the appropriate climb gradients for operations above FL180. Lev Prichard, Allied Pilots Association, requested an invite to the next DWG. Lev brought up a concern with charted procedures with crossing restrictions, but with no climb gradient published that would assist pilots in compliance with the restrictions. This is especially significant in cases where the restrictions are published at intersections, with no way to know the distance from the aircraft's present position to the intersection with the restriction. Gary

McMullin, Southwest Airlines, pointed out those gradients used to be on the charts, but were removed due to criteria changes. John will determine if the DWG is open to non-FAA personnel, and Lev will send specific examples of concern to John to forward to Dan Wacker, FAA Flight Procedures and Airspace Group, the facilitator of the DWG.

**Action Items:**

- FAA Flight Procedures and Airspace Group will report on DWG activities
- Lev Prichard will forward any identified issues on SIDs
- FAA Flight Procedures and Airspace Group will forward identified SID issues and DWG invite requests for outside groups to Dan Wacker

**Status:** Item open

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**Meeting 20-02:** Jeff Rawdon, FAA Flight Procedures and Airspace Group (FPAG), briefed the issue summary and current status from the slide. Lev Prichard, Allied Pilots Association, advised he had not forwarded any SID issues, or worked with Gary McMullin, Southwest Airlines on this particular issue. Dan Wacker, FPAG, said this original topic can be closed based on changes in Order 8260.46G, and confirmed that consideration of ATC requested climb gradients is an ongoing separate topic in the Departure Working Group (DWG). This new issue is being tracked in the US-IFPP and the DWG is providing updates. Gary and Lev concurred with closing the issue.

**Status:** Item closed