

GOVERNMENT/INDUSTRY AERONAUTICAL CHARTING FORUM
Instrument Procedures Group
April 29-30, 1996
HISTORY RECORD

FAA Control # 96-01-166

SUBJECT: **Determining Descent Point of Flyby Waypoints (Originally Submitted as Definition of "On Course" – title changed at ACF 97-01)**

BACKGROUND/DISCUSSION: A question that has long puzzled pilots is the question under IFR Rules of what constitutes being "on course". This question is particularly important for a number of reasons including obstacle protection when turning on course and particularly when deciding when it is proper to begin descent where terrain protection is to be provided by maintaining the published course. A recent airline accident was caused in large part by the airplane descending when the aircraft had unintentionally strayed from the published arrival route on which obstacle protection was based upon maintaining course. So what is considered to be "on course"? Is it when the needle on the CDI is not fully deflected? Is it when the CDI needle is half deflected so there is potentially some additional level of conservatism? Should it be based on a figure shown on a cross track indicator?

RECOMMENDATION: Establish the definition for "on course" to be an understandable definition which also shows the pilot the edge of obstacle containment.

COMMENTS: This recommendation affects the Pilot Controller Glossary and FAA Order 8260.3B.

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INITIAL DISCUSSION (Meeting 96-01): Wally Roberts, ALPA, presented the issue stating that the current definitions in the pilot/controller glossary were inadequate. Paul Best, AFS-420, stated that Flight Standards had studied this issue in the past to no definitive conclusion. He recommended that the ALPA group conduct a study and present a recommendation at the next meeting. **ACTION: ALPA.**

MEETING 96-02: Wally Roberts, ALPA, led the discussion noting that the current definition of "on course" does not support GPS navigation. Don Pate, AFS-450, noted that further discussion of the issue must include resolution of changing sensitivities and the capabilities of receivers to put the pilot on course. RTCA is also addressing the issue as to how it relates to descent points using GPS/FMS systems. A telcon will be held to discuss this at a later date - interested parties are: ALPA, APA, Jeppesen and AFS-420/440/450. AFS-450 will take the lead in establishing the telcon. **ACTION: AFS-450.**

MEETING 97-01: Don Pate, AFS-450, briefed that a telcon was held on March 14 to discuss this issue. Representatives of AFS-440, AFS-450 and ALPA participated. The discussion transcended to “when may descent begin on flyby waypoints”. ALPA took an IOU to prepare a paper on defining “on course” for ACF 97-1; however, it was not presented. This issue will be a subject of discussion at a scheduled meeting between ALPA and AFS-440/450 on April 25. It was agreed to change the issue title to Read: “Determining Descent Point on Flyby Waypoints”. It was suggested that AFS-410 be a part of the solution. AFS-450 will continue working the issue and report results of the April 25 meeting at the next ACF. **ACTION: AFS-450.**

MEETING 97-02: The discussion on “when may descent begin on flyby waypoints” continued. Jim Terpstra, Jeppesen, explained Canada’s desire to establish a flyover fix on the approach course inside the IF. He also recommended that Canada be invited to attend ACF meetings. ALPA took an IOU to prepare a paper defining “on course” at meeting 97-01; however, it was not presented. AFS-450, took an IOU to report progress on the issue at meeting 97-01; however, no report was given. Wally Roberts, ALPA, agreed to send Howard Swancy, Afs-420, a copy of the ALPA “on course” paper. **ACTION: ALPA and AFS-450.**

MEETING 98-01: Jack Corman, AFS-420, briefed that work is not complete on this issue. Report deferred to the next meeting. **ACTION: AFS-420.**

MEETING 98-02: Paul Best, AFS-400, briefed that criteria have been reviewed and that using the fix bisector as a descent point will provide obstruction clearance. Wally Roberts, ALPA, noted that determining the fix bisector is equipment specific. Paul agreed to coordinate with the Tech Center to ensure a valid FAA position on this issue. He will also coordinate with Carl Moore, AFS-420, to incorporate results of his study into the AIM. **ACTION: AFS-400 (NAS NRS).**

MEETING 99-01: No report available as the AFS-400 NAS NRS was unable to attend the meeting. **ACTION: AFS-400 (NAS NRS).**

MEETING 99-02: Paul Best, AFS-400 (NAS NRS), briefed that FAA General Council (AGC) is still working on a FAA definition of “on course”; however, he has no timetable indicating when it will be ready for release. Wally Roberts, ALPA, agreed to prepare a definition for consideration working through Paul as the FAA Flight Standards point of contact. Once a definition is developed, AFS-420 will present it for AIM publication. Subsequent to the meeting, Wally advised that ALPA would like to further address the ‘bisector concept’ to ensure that proposed RNP protected airspace issues are addressed in the “established on course” definition. He indicated that he requests to work this issue jointly with AFS-420. **ACTION: ALPA, AFS-400 (NAS NRS) and AFS-420.**

MEETING 00-01: At meeting 99-02, ALPA agreed to prepare a draft definition of “on course” working through Paul Best as the FAA Flight Standards point of contact. Bill Hammett noted that a copy of Carl Moore’s, AFS-420, paper on using the bisector as descent point on flyby waypoints is included in the meeting handout. Jim Terpstra, Jeppesen, noted that this is a good example of the type item that should be included in the proposed AC90-XX. He also stated that this philosophy should be written somewhere as an official source document for data base manufacturers. Kevin Comstock, ALPA, echoed that the paper should be given wide dissemination and perhaps included in the AIM as a temporary measure. Kevin also noted that ALPA believes that a limitation on ground speed should be included in the bisector concept to ensure containment within the obstacle area. AFS-420 will pursue further publication of the paper. **ACTION: AFS-420.**

MEETING 00-02: Dave Eckles, AFS-420, presented a status update paper on the issue. Subsequent to the last ACF, it has been determined that certain navigation equipment will not permit descent from the intermediate fix altitude to the FAF altitude unless the aircraft is within a specified distance of the intermediate course, on an intercept heading, or in some cases, wings level. The result is that the altitude to be lost between the IF and FAF may exceed TERPS descent gradient standards. A new study is underway within AFS-420 to evaluate various associated parameters such as ground speed, angle of turn, altitude to be lost, and bank angle and their interrelated effect on required intermediate segment length. Results of the study will be incorporated into TERPS for use in procedure design. **ACTION: AFS-420.**

MEETING 01-01: Dave Eckles, AFS-420, briefed that there are still some open issues and the matter is not fully resolved within AFS-420. When resolved, pilot education material for the AIM will be developed. **ACTION: AFS-420.**

MEETING 01-02: Norm LeFevre, AFS-420, briefed that FAA policy has not been resolved. There is no change in status. **ACTION: AFS-420.**

MEETING 02-01: Norm LeFevre, AFS-420, briefed that there is no avionics system that will tell the pilot when the aircraft reaches the bi-sector point in turns and that he has requested that AFS-410 respond to the issue. The following day, Hooper Harris, AFS-410, provided an in depth briefing on the issue noting the requirements of Part 91.181, the pilot practical test standards for course maintenance, and the pilot guidance published in AIM paragraph 5-4-7(c). Hooper noted that the bi-sector concept does not fall within any of the above guidance. Hooper proposed that new guidance be developed through the ACF to address descent after a flyby waypoint/fix to include positive course guidance requirements and an acceptable definition of “on course” (within 10°, off the peg, etc.). These solutions may require resolution of additional issues; e.g., minimum segment lengths may have to be extended, turn protection areas may need enlarging, new practical test standards may need to be developed and pilot education material revised. Steve Bergner, NBAA, recommends establishing speed standards for turns, especially at Intermediate Fixes. Steve also recommended that VNAV avionics that do not provide bi-sector information have their certificate withdrawn. Wally Roberts, ALPA, also recommended a 200 KT speed limit and a crosscheck of distance from the fix prior to starting a turn. Al Herndon, MITRE, noted that the problem also exists in the en route environment. Brad Rush, AVN-160, recommended

that FAA avoid using “should” in future avionics specifications. Jim Terpstra, Jeppesen, added that existing TERPS criteria should not be modified due to the large number of procedures in print. He added that avionics standards must not be revised “after the fact”. Hooper agreed that AIM guidance could resolve the issue and agreed to draft AIM language in concert with Wally for presentation at the next meeting. **ACTION: AFS-410 & ALPA.**

MEETING 02-02: Hooper Harris, AFS-410, briefed that the agreements discussed at the last ACF remain valid; however, no action has been taken yet. The necessary AIM information is still planned for submission NLT February 20, 2003 for publication in Change 3 on August 7th. **ACTION: AFS-410.**

MEETING 03-01: Rich Gastrich, AFS-410, briefed that the agreements discussed at ACF 02-01 remain valid; however, no action has been taken to date. The AIM cutoff for the August AIM change was missed. Rich assured the group that the information would be forwarded NLT than August 7th for AIM/AIP publication on February 19, 2004. The draft AIM change will also address maximum speeds, distances, etc. Bill Hammett offered to circulate the draft AIM change through the ACF membership for comment if so desired by AFS-410. **ACTION: AFS-410.**

MEETING 03-02: Bill Hammett, AFS-420 (ISI), briefed the group that AFS-410 had developed AIM material to resolve this issue based on previous ACF discussions. However, as a result of an internal AFS-400 non-concur, the material did not make the August 7th cutoff for publication in the February 19, 2004 AIM. Work to resolve the non-concur is ongoing and it is expected to be complete in time for submission on February 19th for the August 04 AIM. **ACTION: AFS-410.**

MEETING 04-01: Vinny Chirasello, AFS-410, briefed that there is no change in the status. A second resolution developed by his office was met with a second non-concur within AFS-400. The non-concur centered on different phases of flight, types of procedures, and differing avionics functioning. Work to resolve the non-concur prior to the August 7 AIM cut-off date is ongoing. **ACTION: AFS-410.**

MEETING 04-02: Vinny Chirasello, AFS-410, reported that there has been no progress on this issue. Tom Schneider recommended the issue be presented to the AFS-400 Technical Review Board (TRB) meeting for input. AFS-410 has the IOU to place the issue on the TRB agenda and continue efforts to develop AIM guidance. **ACTION: AFS-410.**

MEETING 05-01: Vinny Chirasello, AFS-410, briefed that no progress has been made on this issue. He will place the issue on the AFS-400 TRB agenda to resolve the AFS-420 non-concur. **ACTION: AFS-410.**

MEETING 05-02: Vinny Chirasello, AFS-410, briefed there has been no action on this issue. Steve Bergner, NBAA, stated that the subject is important and needs clarification and resolution. Brad Rush, NFPG, added that the issue is not limited to approach procedures.

Vinny promised to pursue resolution more aggressively through an AFS-400 Technical review Board (TRB). **ACTION: AFS-410.**

MEETING 06-01: Vincent Chirasello, AFS-410, briefed the issue was discussed at an AFS-400 Technical review Board (TRB) after the last ACF meeting. However, the language never made it to the AIM. Vinnie added that his office is staffing a request to adopt the ICAO definition of "on course" for FAA use. He promised AIM material prior to the cutoff for the Feb 07 AIM. Tom stated he would circulate the AIM proposal to the ACF-IPG Master Mailing List for comment as soon as received from AFS-410.

ACTION: AFS-410 and ACF-IPG Chair.

MEETING 06-02: Robert (Rico) Carty, AFS--410, briefed that there has been no progress on this issue. **ACTION: AFS-410.**

MEETING 07-01: Ernie Skiver, AFS-410, briefed that there has been no progress on this issue. Wally Roberts, NBAA, briefed that TSO 149 and 146 boxes switch to the next leg at the bisector of the fix. Brad Rush responded that flight inspection practices are not to descend until the aircraft is wings-level after the turn. **ACTION: AFS-410.**

MEETING 07-02: Mark Steinbicker, AFS-470, briefed they are still assessing how different avionics systems operate as not all use the same methodology; e.g., some FMS systems recognize and begin descent at the bisector of the turn, others operate in a different manner. Mark briefed that the operational expectation in ACs 90-100 and 90-101 is for pilots to be contained within .5 of the required accuracy for straight segments and within 1 times the required accuracy during turns. Tom Schneider, AFS-420, asked whether AC 90-94, would also address the issue. Mark replied that AC 90-94 may go away to be replaced by a new AC that would incorporate all RNAV and RNP procedures. Brad Rush, AJW-321, cautioned on changing criteria as some boxes cannot accommodate the current design; e.g., wings-level prior to ramping down. Rich Boll, NBAA, asked if there was intent for a pilot to have to switch in/out of VNAV mode and whether VNAV systems approved IAW AC 20-129 will meet the new requirements. Mark replied that the pilot should not have to switch modes and that he sees no problem with existing AC 20-129 VNAV systems complying with the proposed changes. Kevin Comstock, ALPA, said .5 of the required accuracy (or ½ the RNP required) was chosen in AC90-100 for straight segments, but he didn't think the same applied for turns. Mark replied that systems that generate a path around a turn need to ensure containment within 1 times the required accuracy. If the system does not generate a path, pilots must minimize overshoot or undershoot and return to the course as soon as possible. Descent upon waypoint sequencing should be OK as long as deviation is within the aforementioned limits. All agree that updated guidance must be written; AFS-470 will continue working the issue. **ACTION: AFS-470.**

MEETING 08-01: John Swigart, AFS-470, briefed that he is the new specialist for this issue. He realizes the issue has been on the “back burner” for some time and promised that he will work with MITRE to provide an update at the next meeting. Rich Boll, NBAA, requested the status of AC 90-94 and the new AC 90-RNP which is under development and being worked through the PARC. Mark Ingram, ALPA, asked whether this should be an issue for the USIFPP. Tom Schneider, AFS-420, responded perhaps so, since an AC revision is involved. John added that the issue is being addressed by several groups; however, his office will continue efforts to resolve the issue and develop AIM material. He will also provide an update on status of draft AC 90-RNP. **ACTION: AFS-470.**

MEETING 08-02: Mark Steinbicker, AFS-470, briefed that they are still working the issue although it is on the ‘back burner’. Analysis by MITRE is on-going with solutions for both automated and non-automated aircraft under consideration. Tom Schneider, AFS-420, stated that AC 90-RNP, which has been coordinated, will address RNP operations. Mark responded that comments received on AC 90-RNP, which will cancel AC 90-94 and 90-97, have been adjudicated and higher policy decisions are in progress. The AC is targeted to enter the AFS-1 signatory process in November. Mark added that AIM information must still be developed. **ACTION: AFS-470.**

MEETING 09-01: Catherine Majauskas, AFS-470, briefed that MITRE has also been accomplishing a study of this issue, which should be complete in June. After the study is complete AFS-470 will develop applicable AIM guidance. The goal is to have the AIM language and AC90-RNP completed in the Fall of 2009. John Swigart, AFS-470, stated a full briefing would be provided at the October ACF-IPG meeting. **ACTION: AFS-470.**

MEETING 09-02: Al Herndon, MITRE, provided a briefing on a MITRE study that assessed FMS performance regarding descent at the waypoint bisector. The study included all FMS manufacturers and used a standard route for all systems. The route included a SID from Ontario, CA followed by flight through several en route points with altitude changes to connect with the RIIVR 2 STAR into Los Angeles. The tests confirmed that all aircraft were well within the TERPS lateral protected airspace for the turns. Additionally, all fully automated VNAV systems met the required altitude restrictions at the bisector. 91% of FMS units tested were within 150 feet of the calculated altitude at the course change bisector in a descending turn. The remaining 9% that were not within 150’ were caused by early descent. Based on the study, Al recommended the issue be closed. Tom Schneider, AFS-420, stated that we have not satisfied the initial request and recommended that the issue remain open until AIM language has been published. A copy of the MITRE study is included here  . AFS-470 will use the results of the MITRE study to develop AIM and other educational material. **ACTION: (AFS-470).**

MEETING 10-01: Bruce McGray, AFS-410, presented a status update paper on the issue requesting that the attendees review it and provide feedback prior to July 16. After all comments are reviewed, AFS-410 will provide a final decision back to the ACF-IPG for consensus and closure. An excerpt of Bruce's paper follows:

"On course for situations involving various levels of FMS/ LNAV/ VNAV equipped aircraft, and with varying levels of automation are broken down to

three answers for aircraft on course to a fly by waypoint and are going to change course to a different track outbound from the waypoint.

Disclaimer: There is no standardization mandated among today's technologically advanced avionics systems that are LNAV/VNAV capable, or GPS/RNAV equipped. Pilots must be fully aware of AFM limitations for their systems, and all specific operating information for the particular hardware and software versions they are using. Those specifics supersede any general statement below, that may or may not apply, given what is in an AFM limitation or system operating description. In all cases, for any of these GPS/RNAV equipped aircraft, the aircraft is considered to be on course any time the course indication is within ½ scale deflection of being centered.

Background conditions for all GPS/RNAV equipped aircraft:

- a. Confirm aircraft is operating in the proper mode – en route, terminal within 30 miles of destination, or approach mode within 2 miles of FAF.
- b. Verify proper indication of course line for required accuracy.

Many units go from white to magenta on the course if all conditions are correct.

1. Fully automated FMS/FMC with LNAV/VNAV [example: NextGen 737-700, 800, 900 with Smiths FMS]: The aircraft is on course inbound, during the turn, and in the descent at the bisector, as the aircraft transitions from the inbound segment to the next published track.

Other conditions:

1. The aircraft is past the flyby point bisector.
2. RNP/ANP values are confirmed within parameters for the appropriate segment.
3. Actual cross track is confirmed to be as commanded by the FMS/NAV system.

2. Partially automated FMS/FMC with LNAV/VNAV but not VTS equipped: The aircraft is on course inbound, also during the turn, and in the descent at the bisector, if the pilot operates the system to properly follow command bars [or command lines], and manages descent to begin after crossing the bisector. If following commands properly, Those FMS commands will roll the aircraft out of the turn on course, with aircraft positioned on the course center line.

3. PART 23 Aircraft RNAV/GPS presentations without the above types of automation: The aircraft is on course inbound while the CDI is within ½ scale full deflection. The pilot should use normal lead points (anticipatory turns) for making a fly-by turn, and is on course for the next segment when the aircraft is within ½ scale deflection of course being centered. For this type of system, descent to a new authorized altitude should be begun when on course on the new segment."

Several comments followed the presentation. Mike Frank, AJT-28, asked whether Part 23 operators that are not auto-pilot equipped were considered. Bruce responded that he needed feedback from part 23 operators as lower end systems function differently. He believes high-end avionics systems are OK with pilot confirmation. Steve Serur, ALPA,

asked whether all operators use the same scale. Rich Boll, NBAA, confirmed that FAA Certification (AIR) needed to weigh in and criteria must be established for scaling. Al Herndon, MITRE, noted that the paper he presented at the last meeting contradicted some of Bruce's assumptions. A full functioning Flight Management Computer (FMC) will begin descent to meet a required altitude at the bisector, not wait until the bisector to initiate descent. If a subsequent waypoint specifies a lower crossing altitude, the FMC will not begin descent at the previous waypoint, rather it will compute a start descent point to accommodate the next lower altitude. participants are encouraged to provide feedback to Bruce at bruce.mcgray@faa.gov. AFS-410/470 will jointly evaluate feedback and develop AIM/AIP guidance for ACF-IPG consideration. **ACTION: AFS-410 and AFS-470.**

MEETING 10-02: John Blair, AFS-410, briefed that work is continuing; however, progress has been slowed due to medical issues involving Bruce McGray, the staff specialist assigned the issue. Bruce is still on medical leave and will re-energize the issue with AFS-470 upon his return. **ACTION: AFS-410 and AFS-470.**

MEETING 11-01: Bruce McGray, AFS-410, briefed that all comments are in and AFS-470 is finalizing the AIM language. It is expected to be submitted in August for publication in February 2012. **ACTION: AFS-410 and AFS-470.**

MEETING 11-02: Kel Christianson, AFS-470 briefed that the following was submitted for publication on July 21, 2011 and will be published in the February, 2011 AIM:

New AIM paragraph (either 5-5-16a,11 or 5-5-16b):

11. Definition of "established" for RNAV and RNP operations.

An aircraft is considered to be established on-course during RNAV and RNP operations anytime it is within 1 times the required accuracy for the segment being flown. For example, while operating on a Q-Route (RNAV 2), the aircraft is considered to be established on-course when it is within 2 nm of the course centerline.

NOTE: Pilots must be aware of how their navigation system operates, along with any AFM limitations, and confirm that the aircraft's lateral deviation display (or map display if being used as an allowed alternate means) is suitable for the accuracy of the segment being flown. Automatic scaling and alerting changes are appropriate for some operations. For example, TSO-C129 systems change within 30 miles of destination and within 2 miles of FAF to support approach operations. For some navigation systems and operations, manual selection of scaling will be necessary.

(a) Pilots flying FMS equipped aircraft with barometric vertical navigation (Baro-VNAV) may descend when the aircraft is established on-course following FMS leg transition to the next segment. Leg transition normally occurs at the turn bisector for a fly-by waypoint (reference paragraph 1-2-1 for more on waypoints). When using full automation, pilots should monitor the aircraft to ensure the aircraft is turning at appropriate lead times and descending once established on-course.

(b) Pilots flying TSO-C129 navigation system equipped aircraft without full automation should use normal lead points to begin the turn. Pilots may descend when established on-course on the next segment of the approach.

AFS-470 to track change until published. **ACTION: AFS-470.**

MEETING 12-01: Kel Christianson, AFS-470, briefed that the change as agreed to by consensus of the ACF and described in the minutes of meeting 11-02 was published in the February 9, 2012 AIM as new paragraph 5-5-16a-11. Kel recommended the issue be closed and the group agreed. **Item CLOSED**