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PILOT JUDGMENT IN TCA-RELATED FLIGHT PLANNING

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"...I pride myself on giving clear TCA-avoidance training to students, so it is with some chagrin I admit to possibly entering TCA [air]space without permission....

"[We] climbed to 1400' (below TCA at 1500')...and began tracking inbound. I used this radial to assure...TCA avoidance...However, the student tracked right of course 2-1/2 dots...perhaps back into the TCA....

"...I let myself be distracted by the possible incursion into the TCA, so I directed my attention to the right side of the craft to identify landmarks and ascertain my exact position. Meanwhile...a heavy aircraft was above and to the left, hidden by the left high wing from the student. We were level at 2900' (below TCA at 3000'). I took the craft over, descended right to assure adequate clearance....

"Teaching primary students can be a workload of its own. Combine that with TCA avoidance, and anti-collision avoidance in a busy airspace and I realize there are safety issues I had not explored before...." (ASRS Record 81719)

INTRODUCTION

Flight in the vicinity of Terminal Control Areas (TCAs) provides numerous opportunities for VFR pilots to challenge their judgment and decision-making skills. As air traffic volumes grow and implementations of positively controlled airspace increase, the exercise of these skills will become more and more routine. During the past several years, public concern with accidents has caused the FAA to vigorously enforce rules regarding TCA requirements. Thus, pilots are now expected to plan their flights meticulously and wisely, if for no other reason than fear of the consequences associated with a TCA violation.

Separating IFR aircraft, especially air carrier transports, from their smaller and slower VFR counterparts was the primary concern behind the initial implementation of TCAs in the late '60s and early '70s. Since that time, there have been two major accidents involving collisions between VFR general aviation aircraft and IFR airliners. Each of these accidents has evoked a public concern to which the FAA responded by proposing TCA expansions, new equipment requirements, and stricter enforcement.

The first accident occurred in San Diego in 1978, when an air carrier approaching Lindbergh Field collided with a departing Cessna. In the wake of this event, a TCA was installed over San Diego, and many Terminal Radar Service Areas (TRSAs) were added across the country.

Recent attention given TCAs arises primarily from the repercussions of the 1986 midair collision over Cerritos, California. In this accident, a VFR aircraft departing an airport underlying the Los Angeles TCA climbed through the TCA floor without clearance, subsequently colliding with an air carrier DC-9 on arrival to Los Angeles International. It was never determined whether the VFR pilot's airspace violation was intentional, and his aircraft's lack of altitude encoding radar transponder inhibited air traffic controllers from recognizing the collision hazard. However, assuming that he did not intend to enter the TCA, it can be inferred that some deficiency, either in his flight planning or navigation procedures, led to his error.

In the wake of the Cerritos accident, the FAA convened a Terminal Control Area Task Force which recommended that the agency study "user knowledge and attitudes" toward TCAs. In response, the FAA requested that NASA's Aviation Safety Reporting System (ASRS) use its incident data toward meeting this need.

ASRS initiated a research study based upon reports describing events related to the presence of a TCA. Many aspects of TCAs were evaluated. Included were pilots' experiences with air traffic control, their navigation practices, flight planning, understanding of regulations, attitudes toward FAA policies, individual training histories, and individual flight experience.

PURPOSE

This paper focuses on the flight planning process when flying near TCAs. Specifically, it considers the judgment deficiencies pilots may exhibit when their knowledge is lacking or their perceptions are inaccurate. It also describes circumstances in which pilots' flight planning decisions may foster unexpected problems or pilot errors.

In addition, we discuss implications of the above for the present-day pilot training process, and suggest areas where the current FAA flight training curricula may be enhanced to increase pilot awareness, improve flight planning practices, and decrease TCA-related problems.

APPROACH

The information presented in this paper is drawn from 75 recent ASRS reports involving TCA issues. In addition to the incident descriptions contained in these reports, a telephone interview based on ASRS's structured callback method was conducted with each reporter. The callback questionnaire sought information on a wide-range of topics pertinent to TCA-related problems; however, only those data related to flight planning issues are discussed here.

Responses to the callback questions were analyzed in combination with the reporters' incident descriptions. We evaluated pilot errors leading to problematic or illegal TCA encounters, and we identified factors and conditions that repeatedly predisposed such errors. Statistically significant correlations among callback responses were also sought to identify factor relationships that may be less than obvious. Finally, we combined this ASRS research data with our flight instructor experience to contrast current pilot training curricula with practical aspects of cockpit and navigation task management as described in ASRS reports.

FINDINGS

Influences on Pilots' Perceptions of the TCA

ASRS reporters interviewed indicated that their perceptions of the purpose, structure, and procedures associated with TCAs are largely shaped by the their flight instructors, the aviation press, and the FAA (through its publications). Asked how they kept abreast of changes within the national airspace system, 75 percent listed aviation journals while 62 percent cited FAA mailings. Only about 50 percent of pilots participating in this study learned to fly in a TCA environment. The remainder learned either before the advent of TCAs or in non-TCA locales.

Awareness of Traffic Flow Paths

A significant minority (39 percent) of interviewed pilots acknowledged little familiarity with the traffic flow paths around those TCAs familiar to them. These flow paths include not only air carrier traffic destined for the central airport, but also a congested mix of VFR aircraft that tend to fly just outside the TCA. Many pilots do not realize that some traffic destined for a TCA's central airport is purposely kept below the TCA floor—the Federal Aviation Regulations (FARs) require ATC to keep only large turbine-powered aircraft within TCA confines. Lack of knowledge concerning traffic flow paths near TCAs implies that, at best, pilots do not consider this information when making their flight planning decisions. Were they more aware of these congested areas, pilots might choose their routes differently.

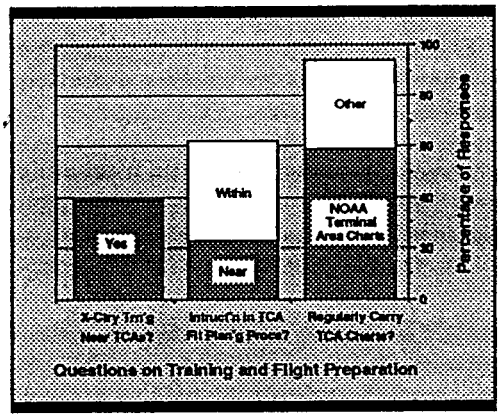
Operational Perception of the TCA

Responses to callback questions concerning pilots' navigation practices collectively suggest that pilots often fail to consider the presence of collision risks near TCAs. As exemplified by the data described below, some pilots may view the TCA only as an area of operational restriction —they are not conscious of the fact that it may harbor real threats. Those who knowingly fly to "just miss" a TCA boundary, and who express no discomfort with doing so, are likely to be unaware that large transports frequently operate precisely at TCA floor altitudes, where ATC procedures and routings often require them to be. These pilots may be further oblivious to the likelihood that other VFR aircraft are flying the same routes as themselves, thus creating traffic congestion near some TCA boundaries.

Flight Planning Practices and Problems

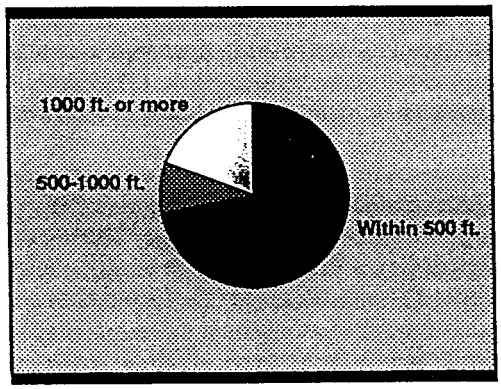
Pilots participating in the structured callback were asked to describe the nature of their primary training with respect to TCAs. A majority said they had never made cross-country training flights near or within a TCA, and 37 percent stated that they had never received instruction on planning such flights (Exhibit 1). These omissions may relate to some of the problems described by ASRS reporters.

Exhibit 1. TCA Training



Choice of flight path and altitude. The *Airman's Information Manual* (AIM) acknowledges that an increased risk of collision may exist near TCAs. In paragraph 97b(2)(d) it cautions VFR pilots "against operating too closely to TCA boundaries, especially where the TCA is 3000 feet or less...[This] will reduce the potential for encountering a TCA aircraft operating at TCA floor altitudes...." Fully 70 percent of ASRS reporters queried, however, admitted that they routinely chose altitudes within 500 feet of TCA floors (Exhibit 2). Furthermore, 88 percent stated that they were comfortable with these margins.

Exhibit 2. Proximity to TCA Floor



The special emphasis the AIM places on TCA areas at or below 3000 feet alludes to but one aspect of the broad set of complications pilots face when choosing their flight routes. TCAs, by definition, are located over crowded urban areas. These areas are inevitably served by several airports adjacent to or underlying TCA airspace, and are often accompanied by Airport Traffic Areas (ATAs), Airport Radar Service Areas (ARSAs), or departure and arrival routes that may impinge upon the TCA. In combination with FARs that mandate minimum cloud and terrain clearances, this complex set of airspaces can make it very difficult for VFR pilots to steer their aircraft along legal routes, much less allow for a TCA buffer.

Contingencies. Some TCA incursions reported to ASRS result from situations where pilots were in the process of requesting TCA clearance. The frequency of these reports strongly suggests that some pilots fail to anticipate the delays they may encounter. Out of fourteen pilots interviewed who reported such incidents, twelve said that they anticipated no delays in obtaining their clearances. In fact, a delay was encountered by eight of them, but only three of the eight said they had pre-planned for such an occurrence.

When pilots intending to gain legal entry into TCAs entered prematurely, the circumstances they described generally fell into two categories: problems with ATC communication, and false pilot expectations. In the first category, some pilots had difficulty in gaining a response to their initial call. Occasionally, they were instructed to stand by before being able to state their clearance request. At other times, the controller took longer than expected to issue the authorization. ASRS reporters often felt that high controller workload, controllers' sometimes uncooperative attitudes toward VFR pilots, and frequency congestion formed the basis for some of these problems.

Pilots themselves admitted to some confusion as to precisely what controller instructions constitute a TCA authorization. Some assumed that when their requests were met with a transponder squawk, heading instruction, or altitude assignment, they had implicitly received clearance. Even though the FAA's handbook, *Air Traffic Control*, clearly mandates that controllers use phraseology similar to "...cleared into the TCA...," pilots may erroneously conclude that, having received a controller's instruction, ATC has now assumed responsibility for navigation. Thus, they believe that separation from TCA airspace is now either assured or implicitly authorized.

Confusion also arose when pilots harbored expectations about the flow of information from one controller to the next. When controllers handed off a VFR flight, some pilots presumed that their TCA clearance requests had also been forwarded. In fact, sometimes they had not. Pilots also expressed dismay when, occasionally, controllers refused outright to coordinate TCA clearance requests with the next sector.

Use of charts. TCAs are most clearly depicted on Terminal Area Charts published by the National Oceanic and Atmospheric Administration (NOAA). These charts use a large scale, and offer information particularly useful to the VFR pilot, including depictions of high density air carrier routes and suggested VFR routes. Other charts, such as Sectionals, WACs, and IFR Area Charts, also depict TCAs, however, their detail is far less than that of the Terminal Area Charts.

Eighty-eight percent of the study's callback participants said that, in general, they regularly carry some type of TCA chart, but it was identified as a terminal area chart in only 59 percent of the responses. When asked, however, if they were using terminal area charts at the time of their reported incident, only 37 percent responded affirmatively, although 55 percent stated that they had used such a chart in flight planning that particular flight. The other pilots acknowledged using other types of charts (usually a Sectional or IFR Area Chart) except for five percent who admitted using no charts at all.

DISCUSSION

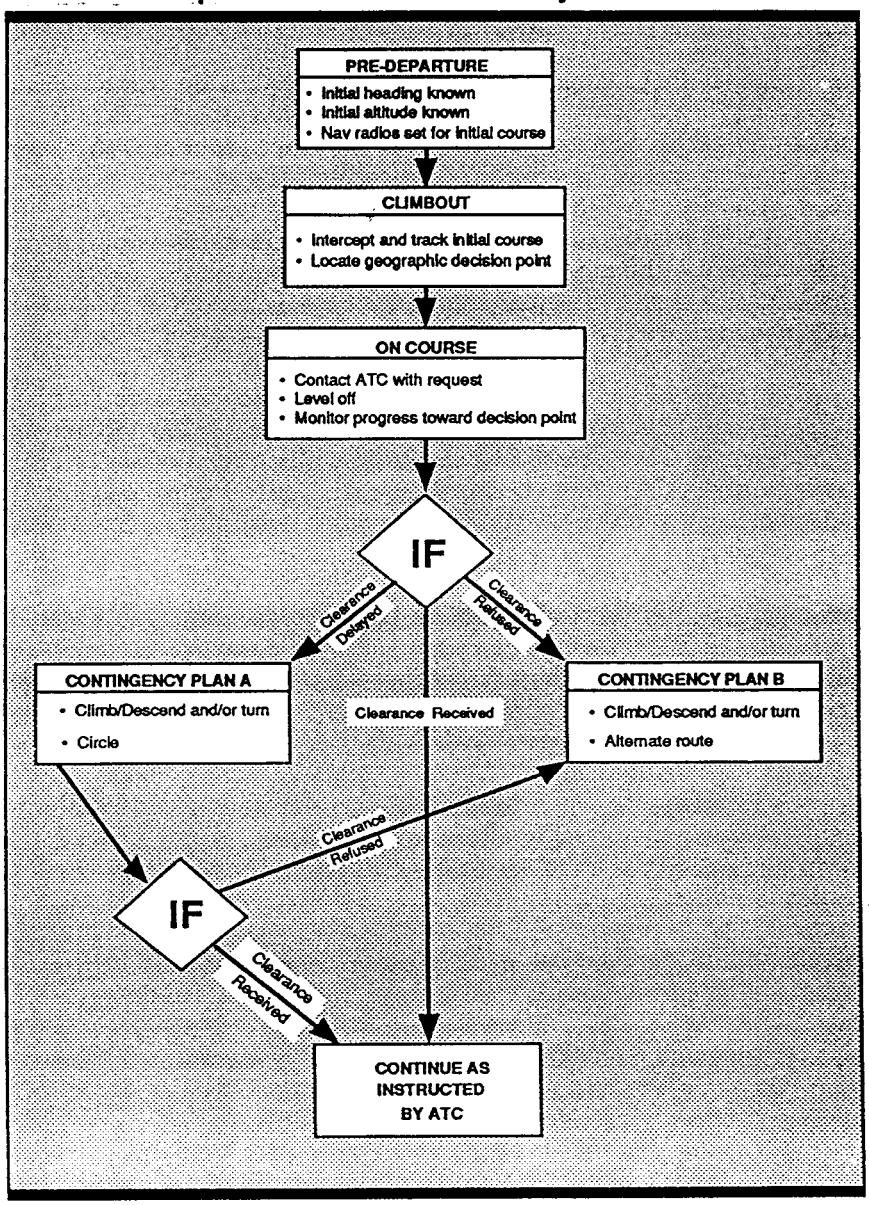
As a flight instructor, the author has developed an approach to VFR flight planning that, while breaking no new ground, goes far beyond the methods included in current FAA curricula. Called "scripting," it requires that, during the flight planning process, students correlate their tasks with their location, to a high level of detail. It further compels students to assume that the ability to complete scheduled tasks may be interrupted or delayed. Therefore, a contingency plan is required for each time- or location-critical task.

Adequate contingency planning requires knowledge of precisely when "Plan B" needs to be implemented. For instance, a pilot departing an airport underlying a TCA in a direction toward the TCA boundary could set up DME, or alternatively, a VOR radial to serve as a decision point. If TCA clearance is not acquired before reaching this point, a 180° turn could be executed. Similarly, and depending upon the circumstance, a pilot may choose an altitude as a decision fix. Failing to gain TCA clearance by the time that altitude is reached would require a temporary level-off.

Any scripted navigation plan must also incorporate the operational tasks relevant to aircraft control (e.g., flap retraction, electric fuel pump operation) and cockpit management (e.g., swapping charts, switching fuel tanks) as well as the routine interactions with ATC (e.g., opening a VFR flight plan with FSS). The script can and should be as detailed as necessary. In essence, it serves the same purpose as a checklist—but is really a procedure customized for the peculiarities and demands of a particular flight. By including even the routine and repetitive flying tasks, the script can aid in managing the distractions and preoccupations so often seen as precursors to ASRS-reported TCA incidents.

Exhibit 3 depicts, in a generic form, the type of cockpit task plan appropriate for a flight wishing to enter the TCA after departing a nearby airport. Navigable paths are chosen that will enable the pilot to keep close track of his aircraft's position. He then chooses crossing fixes (decision points) where contingency actions can be immediately implemented should the task agenda not yet be met. These contingency actions are also planned in detail prior to departure.

Exhibit 3. Sample Task Plan for TCA Entry



The author has observed a lack of focus on detailed flight planning by pilots, instructors, and the FAA. Although texts such as the *Flight Training Handbook* do emphasize the importance of cockpit organization, there is no presentation of methods useful toward task management and navigation. Furthermore, there is no requirement or guidance provided for instructor demonstration of detailed flight planning skills. Whereas some may argue that the methods described above derive automatically from pilots' utilization of common sense and the aircraft's cockpit resources, it seems unlikely that many will make these skills part of their subconscious repertoire until they are practiced with rigor.

CONCLUSIONS

Summary of Findings

Reports submitted to ASRS imply that flaws in judgment are related to incomplete knowledge of the potential conflict risks existing near TCAs. Pilots may fail to recognize the hazards posed by air traffic within or near TCAs, or they may implicitly accept these hazards as they juggle the many factors that bear on their choice of flight path. In addition, some pilots are not prepared for the variables they may encounter when dealing with various elements of the ATC system, and they fail to compensate by planning for contingencies. In this sense, the judgment defects applicable to TCA-related problems are of a cognitive nature.

Some pilots could better plan their flights by using Terminal Area Charts, as opposed to others having considerably less information about the TCA. These charts often include depictions of traffic flows and suggested VFR routings. In addition, they usually provide much greater geographical detail by which TCA boundaries may be identified.

ASRS reporters participating in this research exhibited no intentional disregard for TCA procedures. Although it may be argued that those likely to utilize the ASRS program are already of a safety-oriented mindset, there is no other evidence to suggest that attitude-induced judgment failures play a significant role in TCA incursions.

Many pilots acknowledged significant voids in their training with regard to TCAs. In some cases their primary flight training occurred before TCAs came into existence, and their knowledge of TCA procedures and flight planning skills has been shaped on a "learn as you go" basis. Such pilots may be further disadvantaged by having been taught cross-country flying skills at a time when the air traffic control system in general was much less sophisticated.

The misperceptions and knowledge deficiencies exemplified by TCA-related incidents can likely be traced to omissions in the primary and recurrent flight training curricula. These curricula neither require nor adequately stress the level of flight planning detail that could prevent TCA problems similar to those reported to ASRS.

Ramifications for Flight Training

Overcoming the perceptual and cognitive deficiencies that relate to pilots' problems with TCAs will require specific attention to those problems in both primary and recurrent VFR flight training. ASRS research identifies three specific areas where fundamental knowledge and skills could be enhanced:

1. Pilots, in general, need a better understanding of the division of responsibility between themselves and ATC.

2. Instructors need to teach the specific procedural elements inherent to air traffic control interactions, in highly definitive terms.

3. Instructors need to demonstrate—and demand that their students demonstrate—the skills requisite to detailed flight planning. These include contingency planning and the in-flight execution of contingency plans.

ASRS research into TCA-related safety incidents has been successful at identifying some problematic flying practices that underlie difficulties encountered by VFR pilots when dealing with complex airspace configurations and the air traffic control system. It suggests that enhancing the flight training curriculum and its associated testing regimens can have a positive effect on reducing these occurrences.