COMMENTARY TO AMCC VI.C–*TRANSPONDERS*

c. Use transponders or next-generation position-indicating technologies during in-flight operations, unless otherwise authorized by ATC, inoperable, or not equipped, and use ATC "Flight Following" for VFR enroute operations,

Transponders are important and widely recognized safety tools.[1] As an NTSB Safety Inspector testified, "prudent pilot[s] . . . use [a transponder]. It's a form of insurance."[2] The International Aircraft Owners and Pilots Association (IAOPA) Policy Manual states, "[t]he voluntary installation and use of transponders is encouraged where it can be demonstrated that their use will contribute significantly to flight safety . . ."[3] And the AOPA Safety Foundation urges, "if you operate an aircraft without radios or transponders, consider installing them."[4]

Although transponders are not required equipment on all GA aircraft, the Federal Aviation Regulations (FARs) do require aircraft that are equipped with an operable ATC transponder to operate it when within most airspace.[5] The actual percentage of GA aircraft with operable transponders is below 90 percent.[6] It is claimed, "[m]any pilots turn the[ir] transponder off when leaving terminal areas to 'save' its useful life."[7] And still other aviators resist use of transponders, fearing "Big Brother" and desiring (or even asserting an inalienable right to) anonymity.[8] Such practice is counterproductive and can greatly diminish safety.

Traffic Avoidance – Pilots today increasingly rely on (or at least benefit from) various traffic detection and collision avoidance systems to avoid midair collisions.[9] These systems are generally transponder-dependent. Most function by detecting the transmissions of your aircraft's transponder. Therefore, the ability of these critical systems to alert other pilots of your presence requires the continuous use of transponders.[10] The importance of transponders is further underscored when one considers the periodic lapses of radar coverage and conflict alert services by ATC,[11] and that most airborne traffic avoidance systems operate without assistance from ground-based radar.[12] Indeed, limitations in the availability and skill of traffic controllers,[13] "over-saturation of the existing radar-based ATC system,"[14] and failures of ground-based technologies,[15] further bolster the benefits of constant use of transponders (and at least where cost-effective), collision detection and related technologies.

Limitations of "See and Avoid" – Eighty-two percent of midair collisions occur at overtaking convergence angles. Given this fact, the "see and avoid" method of mid-air collision prevention possesses certain inherent limitations. To the extent that some midair collisions are unavoidable using see and avoid—as this statistic suggests—then the benefit of transponder-based technologies becomes further compelling.[16] The projected increase in flight operations further supports the need for continuous transponder use, particularly since "the incidence of midair collisions shows no corresponding decline."[17]

Pilots should be taught that it is just good risk management to use transponders, including because faster aircraft that are equipped with TCAS systems can see and avoid them, since the faster aircraft may overtake from behind where they cannot be seen.

Impact of Recent Technologies – Many recently deployed navigation and surveillance technologies require (or would be enhanced by) the general use of transponders or related technologies. For example, Automatic Dependent Surveillance-Broadcast (ADS-B)[18] systems, used to identify the location of proximate aircraft, are transponder dependent. Also, the Transponder Landing System (TLS) requires the use of transponders.[19] Separately, various Uninhabited/Unmanned Aerial Vehicles (UAVs), such as NASA's *Proteus*[20] and the U.S. Air Force's *Global Hawk*,[21] rely heavily on transponder beacons to avoid collisions and to "see and avoid (actually, to *sense* and avoid)."[22] The number and missions of UAV will increase while the size of many of these aircraft will downsize (which will have the effect of making them more difficult to see and avoid). UAV-aircraft collisions have already occurred.[23]

UAV–Source: US Air Force

Regulation – Airspace regulation will invariably continue to increase – and correspondingly, increase the airspace controlled by ATC. Positive control of this airspace will be accomplished, in part, via transponders or other position-indicating technologies. In the U.S., some TFRs already permit certain flight operations only as long as they squawk discrete transponder codes and conform to designated procedures. And in Europe, the "One Sky" project may dramatically restrict GA above 9,500 MSL and in terminal airspace, absent the use of designated technologies (including transponders).

Finally, and as a practical matter, the reduced *footprint*, power requirements, and cost of transponders present a better value proposition than ever before.[24]

DRAFTING CONSIDERATIONS:

- ✓ **History:** The previous version of AMCC VI.c (version 1.0) opened with the following provision: "*whenever practicable*, use transponders or next-generation position-indicating technologies during in-flight operations . . ." (emphasis added). Version 1.1 clarifies and underscores pilots' responsibilities by deleting "whenever practicable"[25] and adding the following specific exceptions to the general use of such: "unless otherwise authorized by ATC, inoperable, or not equipped."
- ✓ **Rationale of Revision**: AMCC VI.c. begins with the affirmative language, *use transponders*, to strongly encourage the use of such safety enhancing technologies while respecting practical limitations to their unfettered use. As a model, the AMCC adopts a prudent/safer position that encourages the maximum practical use of available equipment.
- ✓ **Implementation Options:** Implementers are free to modify the text to satisfy the unique capabilities and requirements of each pilot, mission, environments, equipment, and GA organization. Examples of implementation options include, but are not limited to:
  - ❑ personalizing and strengthening AMCC VI.c to read: "For YOUR OWN safety, ALWAYS operate your transponder."[26] Such a substitution might be particularly advantageous in some environments where the pilots tend to be *laissez faire* regarding their use of transponders; and

- advising pilots to use a transponder "in its most effective mode" (*e.g.*, to keep altitude reporting enabled).

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[1] "[T]he proper application of transponder operating procedures will provide both VFR and IFR aircraft with a higher degree of safety . . . ." AIM 4-1-19 *Transponder Operation – General, available at* < http://www.faa.gov/ATpubs/AIM/Chap4/aim0401.html >.

[2] *Beck v. Thompson*, 818 F.2d 1204, 1219 (5th Cir. 1984).

[3] The International Aircraft Owners and Pilots Association (IAOPA) Resolution (14/10), IAOPA Policy Manual, *available at* < http://www.iaopa.org/info/manual.html >.

[4] AOPA Air Safety Foundation, *Collision Avoidance Strategies and Tactics* (2001), at 5, *available at* < http://www.aopa.org/asf/publications/sa15.pdf >.

[5] FAR 91.215(c) *ATC transponder and altitude reporting equipment*; *available at* < http://risingup.com/fars/info/part91-215-FAR.shtml >, FAR 99.12 *Transponder-on requirements*, *available at* < http://risingup.com/fars/info/part99-12-FAR.shtml >.

[6] For example, by aircraft not originally certified with an engine-driven electrical system, balloons, and gliders. (FAR 91.215(b)(3) and ATC authorized deviations (FAR 91.215(d)). One PEB member urged: "For those whose airships are not electrified, my advice has always been . . . get a transponder . . . get a motorcycle battery . . . hook 'em together . . . turn it on and leave it on . . . for your own safety!" Email from Prof. Dale DeRemer, Ph.D. (April 15, 2005).

The first altitude reporting transponders were deployed in PanAm Boeing 707s in 1967. TOM MORRISON, QUEST FOR ALL –WEATHER FLIGHT 218 (Airlife Publ'g Ltd. 2002).

[7] Travis Air Force Base, *Mid-Air Collision Avoidance*, *available at* < http://public.travis.amc.af.mil/public/index.html >. Compare: "Or, in some cases I know of, to 'hide' from ATC, because the pilot is uncertain about the exact position of a TFR, etc – and believes that he can't be seen with his transponder switched off. Clearly, a dangerous and misinformed position." Email from Michael Radomsky, Pres., Cirrus Owners and Pilots Ass'n (Feb. 23, 2005).

[8] This fear is exacerbated with Mode S and related technologies that explicitly transmit an aircraft's tail number. *See generally* FAA, *Mode Select Beacon (Mode S), at* < http://www.tc.faa.gov/its/cmd/visitors/data/ACT-300/modes.pdf >; Emily Chang et al., *The Story of Mode S* (Dec. 2000), *available at* < http://web.mit.edu/6.933/www/Fall2000/mode-s/mode-s.pdf >; *Cf. Automatic Independent Surveillance – Re: Privacy, at* < http://www.gtwn.net/~keith.peshak/AIS-P.htm >, and < http://www.airsport-corp.com/dot_faa_ct-97_7.pdf >. *See* NBAA, *Vendor Code of Conduct at* < http://www.metronaviation.com/cdm/participate/newpaxdocs/ASDICodeofConduct.doc > (Oct. 1998) (GA Privacy Aircraft Situation Display-to-Industry – Blocked Aircraft Registration Request "BARR"). The disclosure of position data associated with the provision of uploaded weather data urges that (at least) some aviation-organization initiative should be undertaken to ensure that such data is voluntarily kept private (for both personal and industrial espionage purposes).

[9] These systems include:

* TAS – Traffic Advisory Systems. "Equipment incorporating a . . . display that indicates the presence and relative location of intruder aircraft, and an aural alert informing the crew of a Traffic Advisory (TA) . . . ." FAA, TSO-C147 *Traffic Advisory System Airborne Equipment*.

* TCAD – Traffic and Collision Alert Device. *See, e.g.*, FAA Order 8300.10 (Dec. 6, 1996), *available at* < http://www.faa.gov/AVR/AFS/FSAW/FSAW9615.DOC >.

* TCAS – Traffic Alert and Collision Avoidance Systems. S*ee* FAR 91.221 *Traffic Alert and Collision Avoidance System equipment and use*, *available at* < http://risingup.com/fars/info/part91-221-FAR.shtml > (requiring all aircraft with TCAS to keep such a system on and operating); FAR 91.223,

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available at < http://risingup.com/fars/info/part91-221-FAR.shtml > (requiring turbine airplanes manufactured after March 29, 2009 with six or more seats to be equipped with TCAS); FAA, AC 120-55A *Introduction to TCAS* (Aug. 27, 1993), *available at* < http://www.faa.gov/fsdo/orl/files/advcir/AC12055A.TXT > (TCAS intended to be a safety net to ATC separation and right-of-way rules); Airport and Airways Capacity Expansion and Improvement Act, Pub. L. No. 100-223 (1987) (establishing requirements for TCAS II on all civil aviation aircraft with more than 30 seats and for mode C transponders); Wendell H. Ford Aviation Investment and Reform Act, Pub. L. No. 106-181 (Apr. 2002) (requiring cargo airplanes of more than 15,000 kilograms MCTOW to be equipped with collision avoidance equipment by Dec. 31, 2002).

* TIS – Traffic Information Systems. Provide alert/display of nearby traffic via Mode S sensor and track reports.

See generally FAA, *Collision Avoidance System* NPRM (2001), *available at* < http://inside.ipapilot.org/committee/engineering/tcas/tcas_nprm.htm > (applicable to operations under part 121, 125, or 129).

* Proprietary/Portable Traffic Proximity Detection Systems. Provide inexpensive and portable traffic detection. Some such systems cost under $300.00 US, *see, e.g.*, < http://www.surecheck.net/avionics/micro.html >.

[10] While the FAR may not require the use of transponders in some operations, there may be an ethical obligation to do so. "Corporate and large aircraft rely on the little guy's transponder for collision avoidance . . . . This is one of my pet peeves as it is a strong indicator of how stupid people can be sometimes. Picture that little cub inadvertently straying across the approach path to an airport with xpdr off -- with a Lear making an approach. If there is a midair the cub pilot is a killer and if he lives should be tried as such and if he dies I wouldn't give a plugged nickel for his estate ever reaching the intended recipients)." Email from Prof. Dale DeRemer, Ph.D. (April 3, 2005).

[11] National Transportation Safety Board (NTSB), *Safety Recommendation* (May 16, 2003), *available at* < http://www.ntsb.gov/recs/letters/2003/A03_17.pdf > ("The Safety Board notes that, although the newer automated radar terminal system (ARTS) 2E and 3E 'Common ARTS' systems are somewhat more sophisticated than the 3A system in that they are more resilient to radar site failures and can more easily integrate other sites, *all versions of ARTS are susceptible to failure modes that leave conflict alert unavailable*. Further, the standard terminal automation replacement system (STARS) currently being deployed by the FAA at some approach control facilities, which, like its predecessors, incorporates conflict alert functionality, has no conflict alert function in its backup mode."), *available at* < http://www.faa.gov/aua/ipt_prod/terminal/ex-stars.htm > (emphasis added). Jane E. Allen, *Vital flight data vanish from screens, report says*, SACRAMENTO BEE (July 18, 1989) ("Critical information on aircraft altitude, speed and direction has vanished from some air traffic controllers screens for as long as 16 minutes because of radar control overload . . . Computer capacity shortfalls at terminal area facilities are widespread"). Consider the July 1, 2002 collision between Russian and DHL jets over Germany, for instance. A "lone Swiss controller, whose center's own computerized alarm system had been shut down for maintenance, had no machine to back him up. Pushed to the limit, he made a wrong decision." George Johnson, *To Err Is Human*, N.Y. Times, July 14, 2002, at WK-1. There were other significant factor in that crash. *See* < http://www.answers.com/topic/bashkirian-airlines-flight-2937 >.

[12] Exceptions include TIS and passive detectors. *See supra* note 9 (describing TIS).

[13] *See* GAO, *FAA Needs to Better Prepare for Impending Wave of Controller Attrition* (GAO 02-591 June 2002), *available at* < http://www.aviationtoday.com/reports/062002attrition.pdf > (estimating that 70 percent of the nation's 20,000 controllers will be eligible to retire by 2011 and predicting about half of those will actually retire – implicating future shortages of controllers). *See* Matthew L. Wald, *Errors by Air Traffic Controllers Rise Sharply in New York; Union Blames Cutbacks*, N.Y. TIMES, Feb. 28, 2005, at A20.

[14] AOPA Air Safety Foundation, *Technically Advanced Aircraft, Safety and Training* (2005), at 27, *available at* < http://www.aopa.org/asf/publications/taa_1_6.pdf >.

[15] *See, e.g.*, Matthew L. Wald, *Maintenance Lapse Blamed for Air Traffic Control Problem*, N.Y. Times, Sept. 16, 2004, at A14 (lapse in routine inspection caused Los Angeles Center radio system shutdown and lost voice contact with 800 planes, "allowing 10 to fly too close together"); Linda Geppert, *Lost Radio Contact Leaves Pilots On Their Own*, IEEE Spectrum, Nov. 2004, 16-17 (recounting impact of So. Cal. ATC communications failure due to maintenance error and finding that "the real hero of the night . . . was the collision avoidance system on board [each aircraft]" *id*. at 17.)

[16] The *Collision Avoidance* report's *see and avoid* statistics did not discern the percentage of MACs [mid-air collisions] where the pilots had negligible opportunity to see and avoid. AOPA Air Safety Foundation, *Collision Avoidance Strategies and Tactics* (2001), *available at* < http://www.aopa.org/asf/publications/sa15.pdf >. "[W]e have not yet determined the number of midair collisions that may be classified as 'unavoidable' . . . the information was not categorized so as to provide the information you requested." Email from Kathleen Roy, Sr. Research Analyst, AOPA Air Safety Foundation (Sept. 9, 2002).

[17] AOPA Air Safety Foundation, *Collision Avoidance Strategies and Tactics* (2001), *available at* < http://www.aopa.org/asf/publications/sa15.pdf >. NASA, *Report of the ASIST Team to the OASTT Executive Council* (Apr. 23, 1997), *available at* < http://avsp.larc.nasa.gov/pdfs/ASIST.pdf > (assuming forecasted traffic increases and no reduction in accident rate). Also, the Secretary of Transportation said that the FAA must triple its capacity to handle traffic in the next few years and yet the administration's budget cuts agency spending by 18%. *See* Matthew L. Wald, *New Planes Crowd Skies Once Left to Big Jets*, N.Y. Times, Mar. 7, 2004, at 17.

[18] *See generally* materials, *at* < http://adsb.tc.faa.gov/ > and < http://www.faa.gov/ntap/NTAP05APR14/gen05002.htm >.

[19] TLS approaches may be deployed at airports where ILS systems are unavailable or infeasible. In such instances, an on-board transponder (required for TLS operations) may provide additional safety options, even for VFR pilots in an emergency. *See* Harry Kraemer, *Transponder Landing System - Precision and Flexibility, Too*, AVIONICS MAGAZINE, Feb. 2003, at 34-36, *available at* < http://www.avionicsmagazine.com >.

[20] Undertaken via NASA's *Environmental Research Aircraft and Sensor Technology* (ERAST), *at* < http://www.dfrc.nasa.gov/Research/Erast/proteus.html >. Proteus was conceived as an "optionally piloted" aircraft at least during cruise -- operated either by a single pilot, remotely from the ground, or autonomously when on station at mission altitude. ERAST uses non-cooperative sensors and transponders (*e.g.*, Active Ranging (radar, ladar), and Passive Ranging (Electro-Optics, & Infrared)). For example, the U.S. Marine Corp use of "a 5.5-pound (2.5-kg) reconnaissance and surveillance drone [and] the Defense Advanced Research Projects Agency (DARPA) will test prototype squad-level Micro Air Vehicles (MAV), aimed at urban warfare . . ." Charlotte Adams, *Minidrones – Near Term . . . and Long Term*, AVIONICS MAGAZINE, Nov. 2002, 34. The use of domestic airborne surveillance aircraft on a 24/7 basis to locate the (Wash., D.C.) sniper suggests that future domestic use of drones may be inevitable. *See generally* Unmanned Systems Online, *at* < http://www.auvsi.org/iraq/index.cfm > (presenting diverse micro drones); Cyrus Farivar, *A Flying Crime Fighter (Some Assembly Required)*, N.Y. TIMES, Jan. 13, 2005, at E7 (UAVs to provide "a low-cost eye in the sky for law enforcement" in So. Cal.)

[21] *See* Air Force Link: Global Hawk, *at* < http://138.145.200.38/factsheets/factsheet.asp?fsID=175 > (Apr. 2002).

[22] "ROA [remotely operated aircraft] Operations should require the proponent to provide the ROA with a method that provides an *equivalent level of safety*, comparable to see-and-avoid requirements for manned aircraft." FAA Notice N-7610.71 (Mar. 1999) (emphasis added). (Note: *Detect*: detect object; *See*: track object, identify collision potential; *Avoid*: decide on evasive maneuver, execute avoidance maneuver), *at* < http://www.psl.nmsu.edu/uav/ >.

[23] Nathan Hodge, *Jumper: Military Must Reorganize UAV Efforts*, AVIATION TODAY, May 3, 2005, at < http://www.aviationtoday.com >.

[24] As a historical note, mandatory transponder use was proposed by the FAA in 1969 within terminal control areas. FAA, *Terminal Control Areas*, NPRM Docket No. 9880 / Rules Docket GC-24, at § 91.90(c)(3) (Sept. 26, 1969). An AOPA response to this NPRM stated, "[w]e understand that at least one manufacturer is now developing a single channel transponder. This would sell for something less than $100 and would have only the VFR Code." Letter from the AOPA to the FAA, Office of General Counsel regarding NPRM 69-41, Docket No. 9880, *Terminal Control Areas: General* (Nov. 14, 1969) (copy on file with author).

Perhaps post-9/11 security requirements could further advance the development of low-cost transponders (or alternative functionally suitable technologies) for the GA marketplace. *See, e.g.*, the Support Anti-Terrorism by Fostering Effective Technologies Act of 2002; Homeland Security Act of 2002, Pub. L. No. 107-296, 116 STAT. 2135 (2002), *available at* < http://www.dhs.gov >. European requirements for elementary Mode S transponders may also catalyze the development of lower-cost models. For example, AOPA-Germany promoted the approval of the Light Aviation Radar Transponder which "will reduce the acquisition cost by more than half." IAOPA, Bulletin, Apr.-June 2004, at 6, *available at* < http://www.iaopa.org/ >.

[25] "[W]henever practical" was viewed by some reviewers as too stringent and monolithic while other reviewers characterized that language as "wiggle words" that were "too amorphous."

[26] Email from Prof. Dale DeRemer, Ph.D. (April 15, 2005).