Automatic Dependent Surveillance – Broadcast (ADS-B) In Retrofit Spacing (AIRS) Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS) Operations and CDTI Assisted Separation on Approach (CAS-A) Operational Evaluation

Final Project Review Report (2023-2025)

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Revision History for

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Executive Summary

Improvements in aircraft communication, navigation, and surveillance systems in the National Airspace System (NAS) have led to the development of multiple concepts to improve safety, efficiency, and throughput. These include the deployment of Automatic Dependent Surveillance-Broadcast (ADS-B). Aircraft equipped with ADS-B receivers (ADS-B In) with Aircraft Surveillance Applications (ASA) systems can receive surveillance information about other aircraft in the surrounding airspace and display this information, as well as application-specific information, to the flight crew.

New ASA-enabled operations, such as Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS) and CDTI Assisted Separation on Approach (CAS-A), are designed to improve safety and help mitigate growth in NAS-wide delays as the number of flights continue to increase.

Both CAVS and CAS-A are ASA-enabled operations that use the same flight deck ASA system and extend/enhance the use of pilot-applied visual separation. To conduct the operations, a flight crew "designates" a Traffic-to-Follow (TTF) in an ASA system and uses a CAVS-capable ASA system to follow the TTF. There are differences between the operations.

In CAVS, a flight crew uses the CAVS-capable ASA system as a substitute for continuous out-the-window visual observation of a TTF during Visual Meteorological Conditions (VMC) on a visual approach behind the TTF. CAVS operations are transparent to controllers since the flight crew uses their CAVS-capable ASA system during current operations as they see fit, without any instruction from a controller to use the CAVS capability.

CAS-A builds on the CAVS operation and uses the same ASA system functionality. However, it is initiated by a controller, who provides a traffic designation instruction including the TTF's call sign. The flight crew identifies the TTF using the controller-provided call sign and designates the TTF in their ASA system. After the flight crew reports the TTF is designated, the controller can issue a CAS-A instruction to follow the TTF to the same runway in conjunction with, or after, the approach clearance. When the flight crew accepts the CAS-A instruction, the controller is relieved of the requirement to apply surveillance separation minima between the TTF and the aircraft conducting the CAS-A operation, and the flight crew follows the TTF using the information available from the CAVS-capable ASA system.

In 2012, the ADS-B In Aviation Rulemaking Committee (ARC) was tasked by the FAA with defining "a strategy for incorporating ADS-B In technologies into the [NAS]". In addition to prioritizing "key ADS-B In applications with the greatest potential," the ARC also recommended that the FAA conduct "flight trials for a sufficient number of ADS-B In applications to validate the utility of operational concepts and validate the business case…"

The ADS-B In Retrofit Spacing (AIRS) project was established for the purpose of conducting large-scale operational evaluations of certain ASAs during revenue service flights using a retrofit solution. A goal of the AIRS project was to evaluate the value of CAVS in large-scale operation over a period of at least one year. Another AIRS project goal was to evaluate the

operational feasibility and value of CAS-A over a similar period. This report covers impact and utilization results from CAVS and CAS-A operations as well as pilot feedback on ASA system use[1]. Because CAS-A operations had never been conducted before, this report includes additional focus on the CAS-A operational evaluation from both a pilot and controller perspective.

American Airlines (AAL) retrofitted their entire Airbus A321 fleet over several years (i.e., mid-2020 to 2023) with the ACSS SafeRoute+ system[2]. Once equipage began, flight crews were able to use this system to track another aircraft in all phases of flight. Between September 2020 (before CAVS or CAS-A approval) and September 2024, AAL flight crews had logged almost 76,000 hours of recorded use. When further examining use of the ASA system within 25 nautical miles (NM) of six AAL hub airports, usage increased over time. Within the 25 NM radius around Dallas-Fort Worth International Airport (DFW) airport, at least 25% of the flight crews used the ASA system to track another aircraft.

CAVS operations were approved by the FAA in May 2021 for AAL flight crews to use in equipped aircraft wherever appropriate conditions exist. The FAA approval had no expiration date, so CAVS operations are ongoing and expected to continue indefinitely.

From March 1, 2023 to February 19, 2025, the CAS-A operational evaluation was conducted with equipped AAL A321 aircraft arriving at DFW in partnership with the Allied Pilots Association (APA), AAL, Dallas-Fort Worth Terminal Radar Approach Control (TRACON) Facility (D10), DFW Tower, Aviation Communication & Surveillance Systems, LLC (ACSS), Federal Aviation Administration (FAA) organizations and their support, and the National Air Traffic Controllers Association (NATCA). These partners were part of the AIRS team that met and discussed on-going operations, solved any issues, considered improvements, and collected and reviewed data. The data collected included sources needed to assess CAVS utilization and impact, CAS-A operational feasibility and impact, as well as general ASA system impact. The results are summarized below and covered in detail in this report.

When pilots in a terminal area use CAVS functionality, on average they achieve more consistent and smaller interarrival distances at the runway threshold, which can increase runway throughput. When the time and distance between arriving aircraft pairs (i.e., Inter-Arrival Time (IAT) and Inter-Arrival Distance (IAD), respectively) were analyzed at six AAL hub airports, flight crews designating traffic (including for CAS-A operations) achieved more consistent and smaller average interarrival distances at the runway threshold than flight crews not designating traffic. However, the minimum IAT/IAD values observed did not significantly change. This effect was shown to be driven by different behavior from flight crews. Across the six hub airports, the average IAT was reduced by 11-13 seconds per arrival runway, and the average IAD was improved by 0.5-0.6 NM per arrival runway, when comparing flights where flight crews designated traffic with those that did not designate traffic. Operational data obtained at DFW demonstrated an average 13-second reduction in IAT per runway; if such an

[1] For virtually all flight crews, use of this ASA system was their first exposure to an ASA during flight operations and these flight crews were able to use the basic traffic display provided in other phases of flight for purposes other than CAVS or CAS-A operations. Therefore, feedback was received about the ASA system in all of its uses.
[2] SafeRoute+ is the brand name that ACSS uses for its certified ASA system.

IAT reduction could be sustained for an hour, arrival throughput could be increased by 4-5 aircraft per hour for each arrival runway.

When pilots using a CAVS-capable ASA system arrived at a TRACON where controllers recognized the equipped aircraft and used a procedure like CAS-A, flight time and distance savings were achieved for all arrivals. At DFW, aircraft conducting a CAS-A operation and flying a downwind segment to landing had an average reduced distance flown of 0.9 NM and an average flight time reduction of 40 seconds, when compared to other traffic. Other aircraft benefited from CAS-A operations; any aircraft arriving within 15 minutes after a CAS-A operation had a reduced distance and time flown, compared to aircraft arriving without a CAS-A operation in a 15-minute timeframe.

When airport weather conditions were less than a 6000-foot ceiling or visibility less than or equal to 8 miles (but with ceiling > 1000 feet and visibility > 3 miles), a CAS-A operation reduced the average distance flown by 0.7 NM and reduced the average flight time by 17 seconds. These benefits increased by a multiple of the number of CAS-A operations occurring in the same 15-minute window. For example, if there were three CAS-A operations in front of Aircraft A in the prior 15 minutes under these weather conditions, Aircraft A would have a reduced average distance flown of 2.1 NM and a reduced average time flown of 51 seconds.

Over the duration of the operational evaluation, CAS-A operations resulted in measured flight time and distance savings for all aircraft arriving at DFW airport of 11,869 NM and 7,188 minutes. Assuming an airline cost of approximately $60 per minute, the results represent a savings of approximately $430,000 for the operational evaluation period. These measured results occurred with only 2.28% of AAL A321 arrivals at DFW conducting a CAS-A operation. If all AAL A321 aircraft had conducted a CAS-A operation[3], the result would be much larger; a simple extrapolation yields a potential annual savings of approximately 158,000 minutes valued at $9.5 M. However, to realize such benefits and take full advantage of the additional gaps created in an arrival traffic flow when CAS-A operations were used, Air Traffic Control (ATC) would have to schedule arrival flows based on anticipated use of CAS-A.

A review of sampled CAS-A operations indicated that the defined procedures, phraseology, and flight-deck interface were acceptable and that such operations worked equally well during visual and instrument approaches. The use of a speed instruction at the discretion of a controller to manage the spacing between an aircraft conducting CAS-A and their TTF appeared to work as well as it does with conventional pilot-applied visual separation operations. The percentage of flight crews that declined or were unable to conduct a CAS-A operation was generally low and no go-arounds were caused by a CAS-A operation.

Most of the challenges during CAS-A operations occurred in the communications associated with flight crew designation of a TTF and were often related to the use of call signs. For example, CAS-A aircraft flight crews sometimes mixed the TTF's call sign with their own when reading back instructions to a controller. Some TTF flight crews heard their own call sign in the controller's traffic designation instruction and asked if a communication was for them.

[3] Having all A321 arrivals at DFW conduct a CAS-A operation would mean that in all arrival rushes, a non-A321 aircraft would have to be the "lead" aircraft in a group of arrivals. This is unlikely to occur all the time.

Communication issues were reduced by modifying the traffic designation phraseology, which reduced the number of times a TTF's call sign would be heard. When communication issues occurred, they were resolved quickly either by the flight crew or the controller. No issues led to an aircraft conducting a CAS-A operation following an incorrect TTF.

Most pilots reported a positive to neutral experience with CAS-A operations. The most noted issues were challenges related to being surprised by the controller's traffic designation instruction and initially performing a new flight deck task. Many issues were mitigated by providing awareness to D10 controllers, increased experience with CAS-A operations by flight crews, and timely AAL bulletins to pilots that provided necessary information to mitigate the issues.

For both CAVS and CAS-A, pilots reported the benefits of added traffic awareness for avoiding overtakes, go-arounds, and slowing earlier than necessary. Pilots generally found the ASA system acceptable, but several pilots reported the need for improved training beyond the initial training bulletin. AAL addressed these requests with iPad-based simulation tools, instructional videos, and special briefings during recurrent ground school and simulator training.

Documented controller feedback was limited, but some D10 controllers conducted numerous CAS-A operations and provided valuable feedback in several interactive settings. D10 controllers noted that although ATC procedure changes during the CAS-A operational evaluation had reduced the controller benefits of CAS-A operations at D10, controllers saw benefits during certain conditions and wanted to continue using CAS-A. D10 controllers also said they believed CAS-A operations would provide benefits for other airports. It was also noted that D10 controllers don't extensively use pilot-applied visual separation in arrival operations. D10 controllers reported challenges with the limited number of equipped aircraft, noting that a CAS-A operation could break their "rhythm" during busy periods.

There were several factors which could explain why the number of CAS-A operations was relatively low and declined in the second year. First, ATC automation did not support the operation – specifically, controllers had to remember who was eligible for CAS-A and there was no automation prompting controllers. D10 controllers said capability indicators on their Standard Terminal Automation Replacement System (STARS) displays were necessary before a larger number of CAS-A operations could be expected. Second, there were multiple changes to DFW arrival ATC operations that occurred during the operational evaluation, including a closed arrival runway and new procedures introduced to ensure safety during turns to final. Third, there were many controller trainees during late 2023 and into 2024 who were not authorized to initiate CAS-A operations.

Overall, the objective findings, along with controller and flight crew feedback, support continued development and integration of CAS-A operations into the NAS to meet the growing demand for safe air travel.

Acknowledgements

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- Allied Pilots Association (APA)
- American Airlines (AAL)
- Aviation Communication & Surveillance Systems, LLC (ACSS)
- National Air Traffic Controllers Association (NATCA)
- Dallas-Fort Worth TRACON (D10)
- Dallas-Fort Worth (DFW) Tower
- Federal Aviation Administration (FAA) employees and their support
    - The Belmont Group, Inc.
    - Blue Mountain Aero, LLC
    - The MITRE Corporation
    - The Regulus Group

Contents

1 Introduction

1.1 AIRS Project Overview

Global air traffic demand continues to rise with predicted year-over-year increases of 3.8%[1]. New capabilities and procedures are needed to increase air traffic safety and throughput to address this demand. Improvements in aircraft communication, navigation, and surveillance systems in the National Airspace System (NAS) have led to the development of multiple concepts to improve efficiency, throughput, and enhance safety. These include the deployment of Automatic Dependent Surveillance-Broadcast (ADS-B) and expanded use of Trajectory-Based Operations (TBO). Aircraft that are equipped with ADS-B receivers (ADS-B In) and Aircraft Surveillance Applications (ASA) systems can receive surveillance information about other aircraft in the surrounding airspace and display application-specific information to the pilot. ASAs such as Interval Management (IM), Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS), and Cockpit Display of Traffic Information (CDTI) Assisted Separation on Approach (CAS-A), are designed to help improve TBO, operational safety, and airspace/airport throughput.

In 2012, an ADS-B In Aviation Rulemaking Committee (ARC) was tasked with defining "a strategy for incorporating ADS-B In technologies into the NAS"[2]. Two key recommendations were made by the ARC. The first was to prioritize "five key ADS-B In applications with the greatest potential to positively affect the ADS-B In business case." These applications included CAVS and a concept termed CDTI Assisted Pilot Procedure (CAPP) from which CAS-A was developed. The ARC also requested that the FAA conduct "flight trials for a sufficient number of ADS-B In applications to validate the utility of operational concepts and validate the business case…"[2].

The ADS-B In Retrofit Spacing (AIRS) project was established for the purpose of conducting a large-scale operational evaluation of ASA systems during revenue service flights. This public-private partnership, covered under a Memorandum of Agreement, included a collaboration between the Federal Aviation Administration (FAA), American Airlines (AAL), and avionics manufacturer Aviation Communication & Surveillance Systems, LLC (ACSS). Other partners include representatives from the National Air Traffic Controllers Association (NATCA) and the Allied Pilots Association (APA).

The operational evaluation enabled the FAA and the airline industry to:

- Evaluate and confirm operational benefit assumptions
- Evaluate the use of an ADS-B Guidance Display (AGD) as a retrofit solution for displaying traffic information in the flight deck forward field of view
- Validate ASA system performance in real-world conditions
- Gather real-world experience to validate future Air Traffic Control (ATC) automation requirements and costs
- Evaluate flight crew and controller acceptance of the operations
- Gain experience on phraseology and procedures for future NAS-wide implementation
- Further the development and deployment of ASA systems

1.2 AIRS Project Operational Evaluation Approach

The AIRS CAS-A operational evaluation involved a unique approach to managing the risks associated with introducing new technologies and operations into the NAS. The operational evaluation was conducted using certified aircraft operating in revenue service but was limited to a specified airspace region, initially for a period of one year and subsequently extended for a second year. The CAS-A operational evaluation did not include any updates to ATC automation. While ATC automation would need to be updated to enable NAS-wide adoption, manual workarounds were used during the operational evaluation. This operational evaluation was not a flight test series involving experimental aircraft, nor was it a NAS-wide implementation. The operations and certified ASA system were intended to be representative of solutions that could be deployed NAS-wide.

The CAS-A operational evaluation approach allowed the FAA and industry to make modifications based on data obtained during the evaluation. For example, based on feedback obtained during the operational evaluation, it was determined that modifications to the initially proposed phraseology would improve the clarity and overall flow of the operations.

To support the evaluation, from mid-2020 until the end of 2023, AAL retrofitted their entire Airbus A321 fleet, comprising A321ceo (current engine option) and A321neo (new engine option) aircraft, with the commercially available ACSS SafeRoute+ system[4], which enabled CAVS, CAS-A, and Initial-Interval Management (I-IM) operations. When the CAS-A operational evaluation began in March 2023, 242 AAL Airbus 321 aircraft were equipped.

CAVS operations commenced after AAL was granted operational approval from FAA Flight Standards in May 2021. CAVS operations are approved for AAL flight crews to use in equipped aircraft wherever appropriate conditions exist and there is no date limitation associated with FAA's approval of CAVS operations. Therefore, CAVS operations are expected to continue indefinitely.

1.3 Document Scope

The purpose of this report is to document results from CAVS operations and the CAS-A operational evaluation. This report measures the impact of CAVS during a two-year period commencing in January 2022. The AIRS CAS-A operational evaluation was conducted in partnership with the Dallas-Fort Worth Terminal Radar Approach Control (TRACON) (D10) from March 1, 2023 to February 19, 2025. This document provides an overview of the CAVS concept[5], a description of the CAS-A concept, a description of the data collection process, a description of the CAS-A operational evaluation, analyses of all data obtained, and lessons learned.

[4] SafeRoute+ is the brand name that ACSS uses for its certified ASA system.
[5] The CAVS concept is described in RTCA/EUROCAE DO-354/ED-233. FAA guidance for obtaining approval for CAVS operations can be found in Appendix B of FAA Advisory Circular 90-114C[18].

2 CAVS Operations and the CAS-A Operational Evaluation

2.1 Development of CAVS and CAS-A

Runway throughput can be increased by relieving the controller of the requirements to apply surveillance separation minima during approaches using pilot-applied visual separation from Traffic-To-Follow (TTF). Concepts have been developed to maintain visual-like separation more safely and efficiently from a TTF using an ASA system during an approach. These concepts are expected to recapture some of the runway throughput benefits of pilot-applied visual separation operations during weather conditions that do not support visual operations, such as when identification of the TTF out-the-window may be delayed or challenging.

An ASA called Enhanced Visual Separation on Approach (VSA) was developed in an RTCA/EUROCAE[6] standards committee and implemented in certified ASA systems[7] to support traffic awareness when conducting pilot-applied visual separation. For VSA, the ASA system can only be used for traffic awareness, and if the TTF is lost out the window, the flight crew must inform the controller. VSA is available in certain Airbus/Boeing aircraft and was found to be beneficial by the United Parcel Service[4]. VSA operations are defined in the Operational Services and Environment Definition in the RTCA/EUROCAE Safety, Performance, and Interoperability Requirements for Enhanced Visual Separation on Approach[5][6] and the avionics requirements are included in the Aircraft Surveillance Applications (ASA) System MOPS[7][8].

Several human-in-the-loop simulations and RTCA/EUROCAE standards development was conducted to build upon VSA and maintain pilot-applied visual-like separation operations more safely and efficiently using an ASA system during weather conditions that may challenge the continuation of such operations. An operational concept was explored for approaches to a single runway in several simulations[9][10][11][12] and at least one simulation explored an operational concept during departure[12].

Some of this simulation work led to and supported the development of RTCA/EUROCAE standards[13][14][15][16] and guidance in FAA Advisory Circular (AC) 90-114A[17] for CAVS. CAVS allows flight crews to "designate"[8] traffic and use specific information from an ASA system as a substitute for continuous visual observation of the TTF during Visual Meteorological Conditions (VMC). Once a flight crew visually acquires the TTF out-the-window and accepts a visual approach clearance behind it, the flight crew may use information from a CAVS-capable ASA system to maintain pilot-applied visual separation from the TTF when out-the-window visual contact with the TTF cannot be maintained. Pilots conducting a CAVS operation cannot enter Instrument Meteorological Conditions (IMC) during the operation. CAVS operations are transparent to controllers since flight crews use a CAVS-capable ASA system during visual approach operations without an instruction from a controller to do so. Figure 1 provides an overview of CAVS.

[6] European Organisation for Civil Aviation Equipment
[7] See FAA Technical Standard Order (TSO)-C195a[3]; note that ETSO-C195a issued by the European Union Aviation Safety Agency (EASA) is equivalent.
[8] See the ASA MOPS[7][8], Section 1.7.1, for the definition of the "Designate" feature in ASA systems.

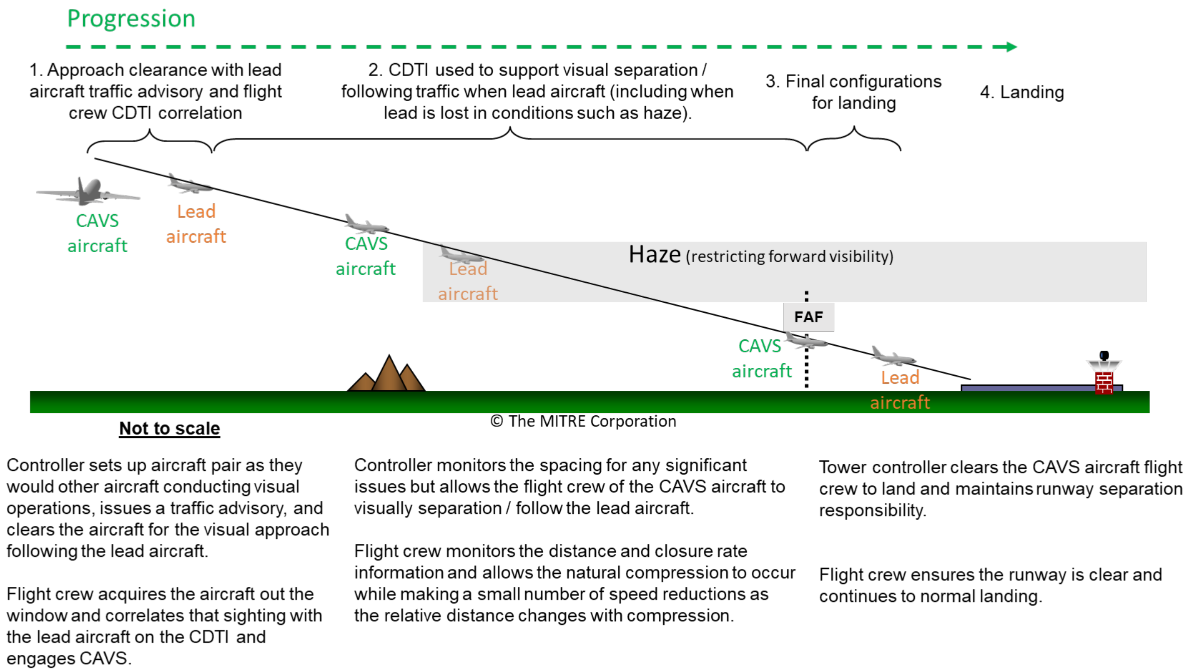


Figure 1 – CAVS Operation

CAVS was part of the AIRS project and AAL received approval from the FAA to use CAVS in appropriately equipped aircraft with trained flight crews in May 2021[9]. CAVS utilization and impact data is included in this report since CAVS operations are similar to CAS-A operations, have similar benefit mechanisms, and use the same ASA system.

CAS-A operations build on the CAVS operation and use the CAVS ASA described in the ASA MOPS[7][8][10] and FAA AC 90-114C[18]. The operational concept for CAS-A was also explored in the same simulations that supported the development of CAVS.

2.2 Overview of CAS-A

A CAS-A operation is initiated by a controller, who provides a traffic designation instruction to a flight crew that includes the TTF's call sign. A flight crew identifies the TTF using their CAVS-capable ASA system and the call sign provided by the controller. Visual acquisition of the TTF out-the-window is not required. Because a controller is providing the TTF's call sign directly to a flight crew, the opportunity for a flight crew to misidentify their TTF, particularly during parallel runway approach operations, is significantly reduced. After the TTF is identified and designated in a CAVS-capable ASA system, a controller can issue a CAS-A instruction to follow the TTF in conjunction with or after the approach (navigation) clearance is issued. When a flight crew accepts the CAS-A instruction, the controller is relieved of the requirement to apply surveillance

[9] US Airways/AAL had prior FAA approval to conduct CAVS operations on equipped A330s using an earlier ACSS SafeRoute system implementation from May 2014, but when the auxiliary displays associated with that ASA system implementation began failing in 2016, AAL abandoned CAVS operations. See the following URL: https://www.faa.gov/sites/faa.gov/files/air_traffic/technology/adsb/quicklinks/CAVS_Benefits_Report.pdf

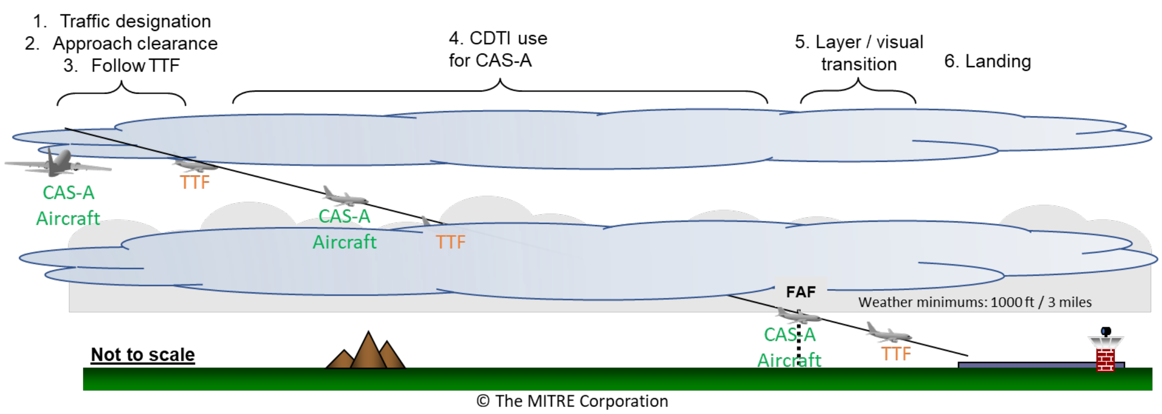
[10] This reference is to the current RTCA/EUROCAE ASA MOPS, but the original CAVS avionics requirements were in the prior version of the ASA MOPS (DO-317B/ED-194A).

separation minima, and the flight crew follows the TTF to the same arrival runway using the information available from the ASA system.

A CAS-A operation does not change any requirements for instrument or visual approach procedures (e.g., accepting or flying such approach procedures) and the CAVS-capable ASA system has no role in flying the approach procedure. CAS-A operations can be conducted when the airport of intended landing is VMC (i.e., a reported cloud ceiling above ground level of 1000 feet or greater and visibility of 3 Statute Miles (SM) or greater). An aircraft conducting a CAS-A operation may enter IMC conditions when flying an instrument approach procedure but must remain clear of clouds if flying a visual approach. If visual out-the-window contact of the TTF is achieved at any point, the flight crew can use the information for traffic awareness but cannot rely solely on out-the-window visual contact to conduct a CAS-A operation.

While CAS-A operations were developed for air transport aircraft arriving at throughput-limited airports, they could be used by any capable[11] aircraft during approach to any runway at an airport where ATC supports CAS-A operations. CAS-A operations do not change any current pilot procedures or responsibilities related to wake turbulence.

Figure 2 provides an overview of a CAS-A operation.



Controller sets up aircraft pair closer than aircraft not able to conduct CAS-A and clears them for the instrument approach and CAS-A (possibly with a speed instruction).

Flight crew identifies the TTF on CDTI and engages CAS-A.

Controller monitors the spacing for any significant issues but allows the flight crew of the CAS-A Aircraft to apply CAS-A from the TTF.

Flight crew monitors the distance and closure information and allows the natural compression to occur and potentially makes a small number of speed reductions as the relative distance changes with compression.

Tower controller clears the CAS-A aircraft flight crew to land and maintains runway separation responsibility.

Flight crew ensures the runway is clear and continues to normal landing.

Figure 2 – CAS-A Operation

2.3 Context of CAS-A Operation

In current operations, typically arrival throughput increases when controllers can assume that flight crews will be able to apply visual separation from a TTF during approach. In the U.S., this typically occurs during visual approach operations, since the weather conditions which allow

[11] This term means an aircraft with appropriate functioning ASA system, a trained pilot/crew, and appropriate regulatory operational approval; see Appendix G of FAA Advisory Circular 90-114C[18] for FAA guidance on obtaining FAA approval for CAS-A operations.

visual approaches also often support pilot-applied visual separation. Arrival rates at airports in the U.S. are higher when controllers can count on visual separation on approach provided by the flight crew. For example, the minimum distance achieved over a runway threshold with pilot-applied visual separation behind Large category aircraft is generally between 2.5 and 3.0 Nautical Miles (NMs) compared to the minimum distance provided by the controller, who must include some additional distance margin to avoid violating surveillance separation minima. This additional spacing results in gaps between successive arrivals of 3 to 4 NM.

During visual approach operations, the primary influence on spacing is runway separation where only one aircraft may occupy the runway at a time, as defined in FAA JO 7110.65AA[19], Paragraph 3-10-3. During instrument approach operations, the primary influence is radar[12] separation minima as defined in [19], Paragraph 5-5-4. Since FAA approach controllers are responsible for separation to the runway threshold, they apply a buffer to the surveillance separation minima, due to the controller's uncertainty about each aircraft's final approach speed.

In current U.S. operations, arrival rates begin reducing when flight crews start reporting to controllers that the airport is not in sight when controllers want to issue visual approach clearances. This occurs at weather ceiling/visibility criteria which are considerably higher than the basic VMC criteria at airports, as shown in Figure 3.

Since visual separation is mainly used during visual approach operations in the U.S., the remaining material in this section will review U.S. visual approach operations and the associated benefits.

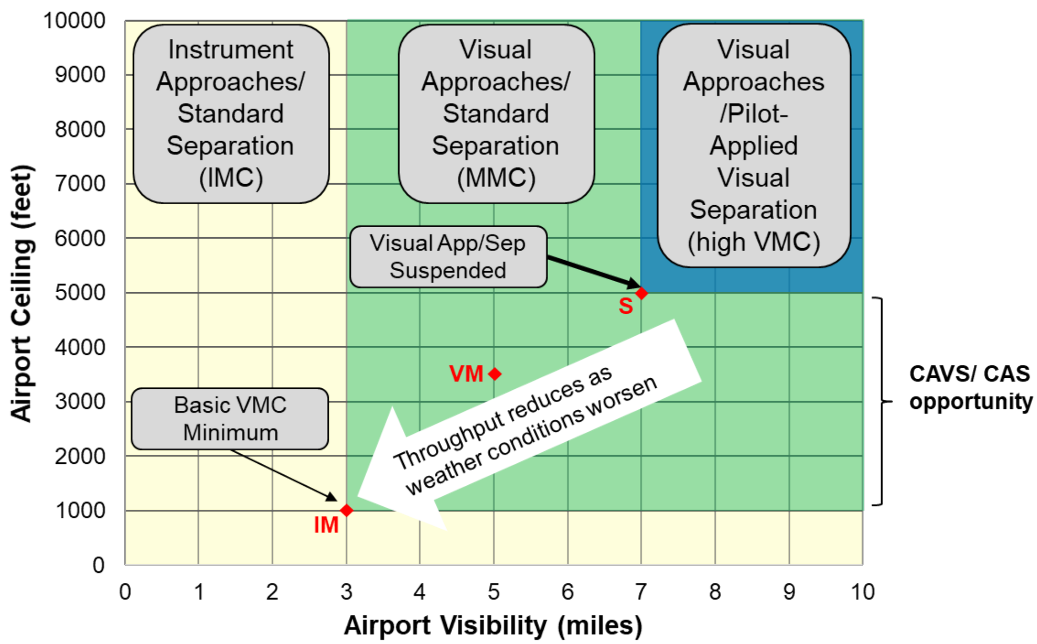


Figure 3 – Weather Conditions for Visual Approach Operations in the United States[13]

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[12] When referring to "radar separation", FAA is describing all separation minima that can be applied with any ATS surveillance system (SSR, WAM, ADS-B) as defined in ICAO Doc 4444 (PANS-ATM)[20]. In this document, the term "surveillance separation" is used.

[13] Figure 3 is a generic representation of airports in the NAS.

Visual approaches can be conducted when cloud ceilings are at least 500 feet above Minimum Vectoring Altitude (MVA) and when visibility allows acquisition of the airport's runway. This is shown by point VM in Figure 3 and is a theoretical number. The actual ceiling/visibility criteria below which an ATC facility suspends visual approach operations depends on when flight crews cannot reliably navigate visually for the approach or visually acquire other aircraft. Since mixing instrument and visual approaches presents challenges for controllers, a relatively small percentage of arrivals not being able to visually acquire either the airport or the TTF can result in suspension of visual approach operations.

The ceiling and visibility criteria below which an ATC facility suspends visual approach operations is usually somewhat higher than point VM. The conditions for suspension of visual approach operations are shown by the point S in Figure 3. Therefore, an ATC facility generally must conduct instrument approach operations (with lower arrival rates) when ceiling and visibility conditions are below point S. This point is typically considerably higher than the basic VMC minima of 1000 feet and 3 miles (point IM in Figure 3).

For example, when DFW is using runways 13R|18R|17C|17L for approaches in "good visual" conditions (i.e., ceilings above 3500 feet and visibility above 5 miles), the rate, known as the Airport Acceptance Rate (AAR), is 114. This reduces to an AAR of 102 in IMC.

CAVS operations allow flight crews to use pilot-applied visual separation when weather conditions are between points S and point VM in Figure 3. CAVS operations cannot bring the higher arrival rate point down to point IM in Figure 3, since the suspension of visual approach operations may occur because the CAVS aircraft is unable to maintain VMC (to fly a visual approach) or is unable to initially acquire the TTF out-the-window.

CAS-A operations can overcome these limitations by relieving a controller of the requirement to apply surveillance separation minima when weather conditions are between points VM and IM in Figure 3. CAS-A operations could enable an ATC facility to approximate visual operation arrival rates when weather conditions are near point IM (1000-foot ceiling and 3 SM visibility).

The CAVS information provided by the ASA system (e.g., call sign, differential ground speed, and distance to TTF) greatly enhances a flight crew's ability to acquire, identify, track, and manage their distance from the TTF. CAS-A operations will enhance traffic awareness and positive identification of the TTF, improving safety.

The realization of some of these benefits will be a function of the percentage of the traffic that is equipped with a CAVS-capable ASA system and able to conduct CAS-A operations. As equipage increases, the benefits will increase, as an ATC facility's traffic management unit is expected to increase the AAR. Early adopters could experience benefits from CAS-A operations at hub airports where the operator has a high percentage of the arrival traffic.

2.4 AIRS CAS-A Operational Evaluation Location

In early 2020, an effort was undertaken to identify an operational evaluation site for CAS-A operations. Criteria were developed to maximize opportunities for CAS-A operations as follows:

- AAL hub airports with sufficient A321 operations
- A range of airport ceiling and visibility conditions for CAS-A operations
- ATC Facility receptiveness
- Lack of operational constraints that would limit or prevent the use of CAS-A operations
    - Crossing arrival runways
    - Taxiway configuration
    - Arrival/departure runways
- Lack of competing FAA programs

Traditional visual approach and pilot-applied visual separation operations can be conducted in periods of high VMC. As noted in Section 2.3, CAS-A operations are expected to recapture some of the runway throughput benefits of pilot-applied visual separation operations during weather conditions that do not support visual operations (above and to the right of point S in Figure 3). These conditions (shaded green in Figure 3) are known as Marginal Meteorological Conditions (MMC) in this report.

It was determined that Charlotte Douglas International Airport (CLT), DFW, and Phoenix Sky Harbor International Airport (PHX) had enough AAL A321 flights to be considered for the operational evaluation. PHX was determined to have limited opportunities for CAS-A operations based on usually having ceiling and visibility conditions that are above MMC. CLT and DFW were the top remaining choices; both airports had a reasonable amount of time when ceiling/visibility were below and to the left of point S in Figure 3 and dedicated arrival runways. However, CLT appeared to have some priority FAA activities that could conflict with an operational evaluation. Therefore, DFW was the final choice.

2.5 Flight Deck Equipment

The same ASA system that is used for ongoing CAVS operations was used during the CAS-A operational evaluation. Equipment requirements for CAVS can be found in FAA Technical Standard Order (TSO)-C195b[21] or later revisions. The ACSS SafeRoute+ system was installed over a period of several years in all AAL A321 aircraft. This ASA system includes use of the existing Navigation Display (ND) for showing designated traffic along with other ADS-B and Traffic Collision Avoidance System (TCAS) traffic (using existing TCAS symbology); the existing Multi-Function Control Display Unit (MCDU) for flight crew data entry and access to operation-specific information; and an AGD (see Figure 4).

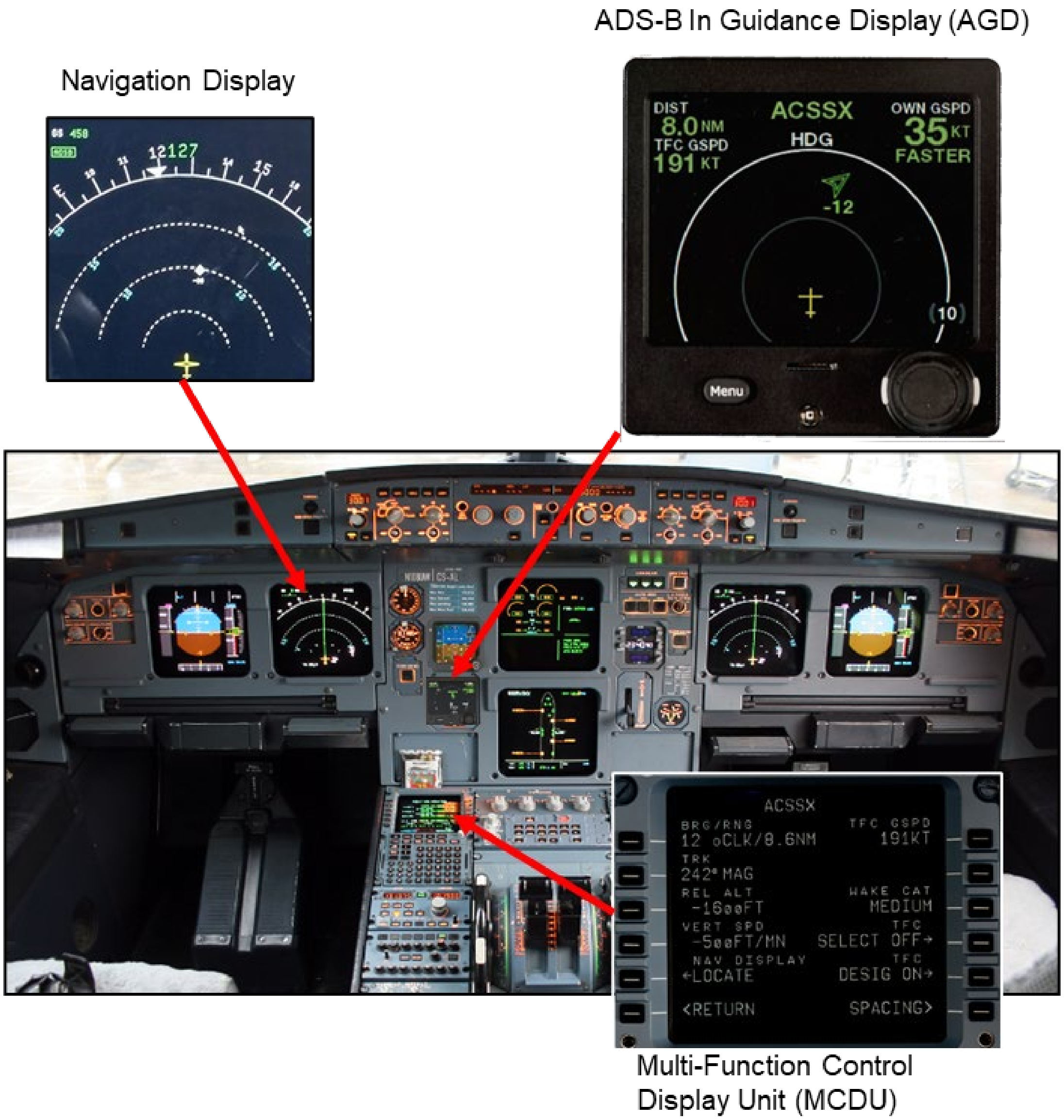

Figure 4 – ACSS SafeRoute+ System Components

TCAS traffic (as provided in the Airbus flight deck) is shown on the ND as well as ADS-B traffic using TCAS symbology. The ND does not provide any information needed for CAVS (or CAS-A) operations other than indicating the designated traffic through pulsing of the TCAS traffic symbol.

The AGD provides a graphical representation of surrounding traffic, similar to the TCAS information on the ND, but adds traffic directionality and traffic information from ADS-B. Relative traffic position for TCAS traffic is displayed on the AGD using typical TCAS symbology (i.e., Other, Proximate, and Traffic Alert (TA)). TCAS Resolution Advisory guidance is not displayed on the AGD.

The MCDU has software pages to allow the flight crew to interact with the ASA system for functions such as entering application data and requesting the display of additional traffic information. See Section 2.5.1 and Section 2.5.2 for more information on how the MCDU is used by flight crews.

The AGD traffic display range can be adjusted to a range of 2.5, 5, 10, 20 or 40 NM. The selected range is indicated above the AGD control knob. When the acknowledge ("ACK") prompt is displayed above the AGD control knob, the control knob button is pressed to dismiss a displayed message. The AGD display orientation can be either heading (HDG) or track (TRK) with the orientation being indicated at the top of the range ring.

Traffic is represented on the AGD using symbol shapes and colors. The most relevant are shown in Figure 5. The color philosophy used for the traffic symbols is defined as follows:

- White – Airborne basic traffic
- Cyan – Airborne selected traffic (and related text)
- Green – Airborne designated traffic (and related text)
- Amber – Traffic caution alerts such as TCAS Traffic Advisory (TA)
- Red – Traffic warning alerts such as TCAS Resolution Advisory (RA)
- Light Brown/Tan – Ground (airport surface) traffic
- Gray – Circular background to a traffic symbol to indicate traffic was selected

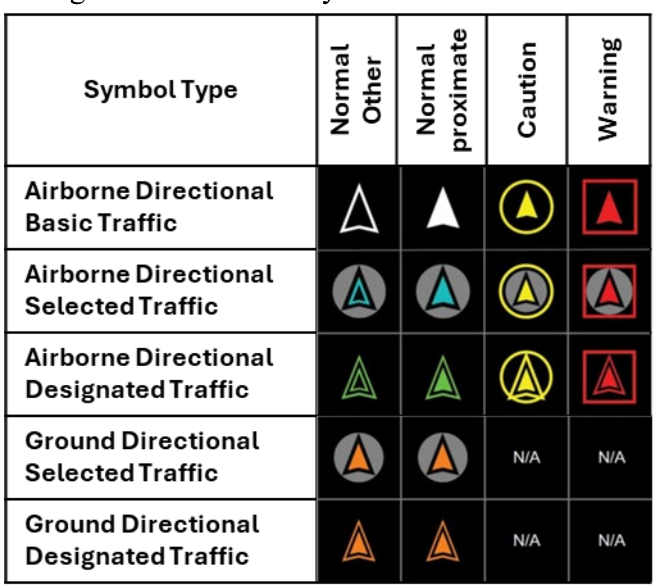

Figure 5 – Most Relevant AGD Traffic Symbols

Traffic data tags are associated with each traffic symbol. If available, each traffic symbol includes the following information:

- Flight identification (ID)/call sign
- Traffic Vertical Direction Indicator (Climb or Descent)
- Traffic Relative Altitude (in hundreds of feet)

2.5.1 Selected Traffic

Individual traffic can be selected on the MCDU Traffic List page for additional information per the on/off prompt shown in Figure 6. After traffic is selected, the MCDU Traffic Information page provides the information shown in Figure 7.

Figure 6 – Traffic Select On/Off Prompt on MCDU Traffic List Page

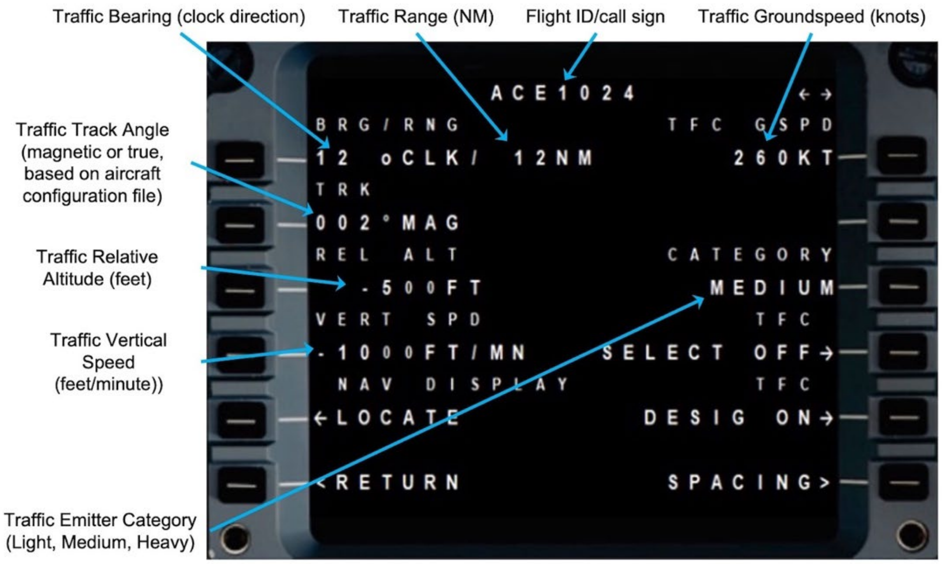

Figure 7 – Example MCDU Traffic Information Page Showing Selected Traffic

When traffic is selected, the AGD traffic display shown in Figure 8 provides flight ID/call sign, distance, and ground speed of the selected traffic. The selected traffic is also highlighted on the AGD.

Figure 8 – Example AGD Showing Selected Traffic

2.5.2 Designated Traffic

In addition to selection, traffic can be designated. Traffic designation is required to perform a specific operation (e.g., CAVS) or for additional traffic awareness. An example of the MCDU Traffic Information page for designated traffic is shown in Figure 9. The flight crew designates traffic from the MCDU Traffic Information page per the traffic designation on/off prompt shown in the lower right of Figure 9. The traffic designation on/off prompt is only displayed on the MDCU Traffic Information page when traffic's ADS-B Out information meets the requirements for performing a CAVS (or CAS-A) operation.

Figure 9 – Example MCDU Traffic Information Page for Designated Traffic

When traffic is designated, a selectable traffic range alert threshold is displayed on the MCDU Traffic Information page in cyan with a default value of 2.5 NM, as shown in the lower left of Figure 9. The flight crew can modify the default value by entering a value from 1.4 to 10 NM.

When traffic is designated, the AGD highlights the aircraft symbol and provides designated traffic's flight ID/call sign, ground speed, and distance from own aircraft. When traffic is designated and airborne, differential ground speed (i.e., difference in ground speeds between own aircraft and designated traffic) is also provided, as shown in Figure 10.

Figure 10 – Example AGD Display Layout for Designated Traffic

Differential ground speed is represented as ownship's ground speed relative to the designated traffic's ground speed, "FASTER" or "SLOWER" in knots. The example shown in Figure 10 indicates that ownship's ground speed is 10 kts slower than the traffic's ground speed.

If the distance (horizontal range) to the designated traffic becomes less than the traffic range alert threshold, the advisory message "TRAFFIC RANGE" is displayed in reverse white and "ACK" is displayed[14] at the bottom of the AGD as shown in Figure 11. There is no associated aural indication. The advisory is inhibited when either ownship or the designated traffic is on-ground. The advisory is acknowledged by pressing the AGD control knob button. When acknowledged, the advisory and "ACK" is removed from the AGD. The advisory and "ACK" is also removed when the horizontal range from designated traffic is greater than the traffic range alert threshold.

Figure 11 – Traffic Range Alert

Two other situations can lead to alerts on the designated traffic: One is a caution alert and the other is an advisory message. When the horizontal range from designated traffic is less than 1.4 NM, a caution message "TRAFFIC MIN RANGE" is displayed in reverse amber on the AGD, as shown in Figure 12, with an aural "TRAFFIC MINIMUM RANGE". This caution alert is inhibited when either ownship or the designated traffic is on the ground. The "TRAFFIC MIN RANGE" message cannot be cleared by pressing the AGD control knob button, but the message is removed when the horizontal range from designated traffic becomes greater than 1.4 NM.

Figure 12 – Traffic Minimum Range Alert

If the designated traffic no longer meets the ADS-B qualification criteria, the advisory message "TRAFFIC LOST" appears in reverse white on the AGD, while simultaneously the designated traffic symbology and all relative distance and groundspeed information is removed from the AGD as shown in Figure 13. There is no associated aural indication. The advisory is acknowledged by pressing the AGD control knob button. When acknowledged, the "TRAFFIC LOST" and "ACK" displayed at the bottom of the AGD are removed.

Figure 13 – Traffic Lost Message

[14] "ACK" is displayed immediately above the AGC control knob button.

2.6 TRACON Ground Equipment

For CAS-A operations, the D10 TRACON controllers used their current ATC automation (e.g., Standard Terminal Automation Replacement System (STARS)). To initiate a CAS-A operation, controllers needed to know which aircraft and flight crews were capable of such operations. Ideally, the STARS display would have provided this indication using filed flight plan information, but such functionality was not available in STARS during the operational evaluation.

The lack of a STARS capability indicator required the AIRS team to define a "workaround" for identifying CAS-A-capable aircraft[15]. The workaround involved AAL filing different International Civil Aviation Organization (ICAO) aircraft type designators in flight plans. AAL A321ceo and A321neo aircraft that were capable (i.e., equipped with the SafeRoute+ system) had their flight plans filed using the "A321" type designator. The AAL A321ceo and A321neo aircraft that were not capable (i.e., not equipped) had their flight plans filed using the "A21N" type designator. This allowed D10 controllers to initiate a CAS-A operation for any AAL aircraft with an aircraft type designator of "A321." Furthermore, D10 controllers knew not to issue a CAS-A instruction to any AAL aircraft filed as "A21N."

The FAA conducted a safety analysis on the proposed workaround prior to implementation. A Safety Risk Management Panel (SRMP) of FAA, NATCA, Professional Aviation Safety Specialists, ACSS, SMEs, and AAL stakeholders was convened in July 2021. The panel evaluated the workaround for the STARS and En Route Automation Modernization automation systems. The SRMP reviewed the proposed change and identified three low-risk hazards that could occur because of the workaround. Results of this SRMP are documented in Appendix 9.4, which was approved in February 2022.

The workaround was used until all operating AAL A321ceo and A321neo aircraft were equipped with the SafeRoute+ system (see Section 2.13). When the workaround was discontinued, all AAL A321 aircraft had flight plans filed with their standard aircraft type designator and D10 controllers were informed that CAS-A operations could be conducted by AAL aircraft using the "A321" or "A21N" aircraft type designators. Note that even without the workaround, having controllers remember that a particular combination of an airline and eligible aircraft type designators were eligible for CAS-A operations was still an interim solution only for the operational evaluation; it was not a replacement for a capability indicator displayed by ATC automation based on flight plan information.

In addition to knowing which aircraft were equipped, controllers needed to know which aircraft were conducting a CAS-A operation. This was done by D10 controllers entering information in the STARS scratchpad via keyboard shortcuts created for this purpose by the D10 STARS technicians. "IC" (Instrument approach CAS-A) was entered into the scratchpad if the aircraft was conducting a CAS-A operation during an instrument approach and "VC" (Visual approach

[15] Since all AAL Airbus single-aisle pilots were trained on CAVS operations with the SafeRoute+ system and on CAS-A phraseology before the CAS-A operational evaluation began, there was no need to track individual flight crew training completion to determine capability to perform CAS-A operations.

CAS-A) was entered if the aircraft was conducting a CAS-A operation during a visual approach. Note that prior to this operational evaluation, D10 controllers were already using the STARS scratchpad to denote aircraft on approach and conducting pilot-applied visual separation ("VS", for visual separation). Figure 14 shows a "VC" example in the lower left data block for AAL727. The IC or VC remained visible to the controller that created the scratchpad entry and was visible to any downstream controller including the Local/Tower controller. Additionally, this "VC/IC" data was recorded/logged by FAA ATC automation systems and was available for subsequent data analysis.

Figure 14 – Example STARS Display of "VC" scratchpad entry for AAL727

2.7 CAS-A Operations

2.7.1 TTF Identification and Verification

The objective of this phase was for the flight crew to have designated traffic on the MCDU Traffic page corresponding to the TTF and verified that the designated traffic matched the call sign provided by the controller.

At D10, a given aircraft's CAS-A eligibility was available to the controllers via the aircraft call sign "prefix"[16] (e.g., AAL) and the ICAO aircraft type designator (as discussed in Section 2.6). TTF identification was initiated by a Feeder or Final controller who had assessed the applicability of using a CAS-A operation in the context of the arrival/approach flow. After deciding to initiate a CAS-A operation, a controller issued a traffic designation instruction to a flight crew.

On receipt of a traffic designation instruction with the TTF call sign, a flight crew was expected to:

- Look at the MCDU Traffic page to identify and designate traffic corresponding to the TTF call sign;
- Confirm the identity of the TTF with the controller if the identity of the TTF was in question;
- Readback the traffic designation instruction to the controller and notify the controller if they were looking for the TTF or had the TTF designated;

[16] Also known as the ICAO Three-Letter and Telephony Designator (3LD); see https://www.icao.int/safety/OPS/OPS-Tools/Pages/3LD.aspx.

- Inform the controller that detection and/or designation of the TTF was not possible if identification was not achieved (or in the case of ASA system error/failure).

The controller used alternate procedures if the flight crew reported no traffic displayed that corresponded to the TTF, the TTF did not qualify for a CAS-A operation[17], or the flight crew was otherwise unable to conduct a CAS-A operation.

While CAS-A operations were initiated by the controller in the operational evaluation, several flight crews took the initiative to advise a controller of being capable and interested in conducting a CAS-A operation. In many cases, these flight crews had already designated the anticipated TTF. It was then at the controller's discretion whether to initiate a CAS-A operation. Similar procedures are followed in the U.S. during standard pilot-applied visual separation operations. The AIRS team discussed whether this was acceptable for CAS-A operations. D10 controllers did not oppose it during the operational evaluation, so AAL flight crews continued to "prompt" controllers for some CAS-A operations.

The identification and verification step communicated the call sign to the flight crew, allowed the flight crew to identify and designate the TTF, and ensured the correct TTF was identified. Identification and designation of the TTF was a mandatory step and had to be completed prior to issuance of the CAS-A instruction. At any point in the Traffic Identification phase, a flight crew could verify the call sign of the TTF with the controller if there were questions about the TTF location or identity.

2.7.2 CAS-A Instruction for Aircraft to Follow the TTF

After a flight crew reported designation of the TTF to the controller, the applicability conditions for a CAS-A operation could be reassessed by the controller. If satisfied, the controller issued the CAS-A instruction to "follow" the TTF in conjunction with or after an approach clearance[18].

The flight crew then reassessed their ability to conduct a CAS-A operation and read back the CAS-A instruction to "follow" the TTF unless an "unable" response was appropriate.

2.7.3 Conducting a CAS-A Operation on the Approach

After accepting the CAS-A instruction, the flight crew used the TTF information provided by the AGD as a substitute for out-the-window information and followed the TTF, analogous to pilot-applied visual separation after being cleared for a visual approach. Note that this phase was essentially identical to a CAVS operation from the flight crew task perspective. The flight crew performed this task by using the ground speed information (i.e., the individual ground speeds and the differential ground speed) and the digital read-out of the horizontal range to the TTF (see Section 2.5 for the information provided by the AGD). These parameters allowed for a better evaluation of the actual distance from the TTF and for an earlier detection of speed variations. A TTF speed reduction could be extremely difficult to detect visually out-the-window and only the

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[17] This was a notification from the ASA system that the TTF did not qualify for designation (identical for CAVS).
[18] Note that the approach clearance was a navigation clearance but "follow" was a separate instruction for the flight crew to maintain a reasonable distance behind the TTF using a CAVS-capable ASA system.

consequence (i.e., a distance reduction) could be visually detected. Using the range and differential ground speed information on the AGD, flight crews were able to detect speed reductions of the TTF and managed their aircraft speed more accurately and quickly to remain a reasonable distance behind the TTF on the approach.

Like a CAVS operation, an aircraft conducting a CAS-A operation is not authorized to use turns or lateral maneuvering to manage their distance behind the TTF without first coordinating with the controller. Such maneuvering was only acceptable when needed to capture and maintain the final approach course. Any turn or lateral maneuver was governed by the type of approach the aircraft was conducting and through controller restrictions/coordination.

If visual out-the-window contact was achieved at any point during the approach, the flight crew could use the information for traffic awareness but could not rely solely on out-the-window visual contact to conduct a CAS-A operation. Once initiated, a CAS-A operation ended when:

- The TTF landed; or
- The Traffic Lost Advisory Alert (aka Traffic Lost Message) was provided to the flight crew; or
- The operation was cancelled by a controller; or
- The flight crew reported “unable” and the operation was cancelled by the controller.

It was an on-going task of controllers to ensure that weather conditions at DFW airport met the requirements for CAS-A operations. If conditions were met at the start of a CAS-A operation and then dropped below requirements during the operation, the controller determined the appropriate action.

After having accepted the instruction to follow the TTF, the flight crew:

- Flew the approach;
- Looked at the TTF information (i.e., distance and relative speed) provided on the AGD;
- Reacted to any alerts (see below) as appropriate;
- Adjusted speed and configuration of their aircraft to follow the TTF at a reasonable distance.

One alerting function is provided in the ASA system to support nominal CAS-A (or CAVS) operations, as described in Section 2.5. If an advisory Traffic Range alert was generated, the flight crew determined if any action or response was required. Flight crew responses could include adjusting speed or contacting the controller for other instructions.

No alerts related to CAS-A (or CAVS) operations are generated when the TTF is on the ground to avoid unnecessary alerts very late in the approach as the TTF rapidly decelerates after landing. When the TTF’s ADS-B signal reports the “on ground” condition during a CAS-A (or CAVS) operation, the Traffic Range and Traffic Minimum Range Alerts are disabled, the differential groundspeed is removed from the AGD, and the displayed TTF symbol changes from a green double chevron to a brown double chevron, as shown in Figure 5.

2.7.4 Cancellation or Rejection

A CAS-A operation nominally ended when the TTF landed, as was the case for a CAVS operation. However, a CAS-A (or CAVS) operation could also end abnormally. In standard operations, a reason for abnormal cancellation of a visual separation instruction occurs when the flight crew perceives visually out-the-window that their distance from the TTF is undesirable or will become unsafe. In such situations, the flight crew applies contingency procedures (e.g., increase distance, conduct a missed approach/go-around, or contact the controller). Since CAVS and CAS-A operations allow for the use of the AGD information as a substitute for out-the-window visual information, standard contingency procedures also apply if the flight crew perceived that the distance from the TTF was too small or trending in the wrong direction using the information provided by the AGD.

In addition, two ASA system alerting functions are provided for off-nominal CAS-A (or CAVS) operations, as described in Section 2.5. These alerts applied to CAS-A operations as follows:

- A Traffic Minimum Range Caution Alert alerted the flight crew that the ASA system was not approved for CAS-A operations at less than the minimum range. If a Traffic Minimum Range Caution Alert was triggered, the flight crew:
    - Contacted the controller; if the flight crew was unable to contact the controller, they executed a missed approach or go-around.
    - If, when contacting the controller, the flight crew had out-the-window visual contact with the TTF, they advised the controller, who could issue a visual separation instruction.
- A Traffic Lost advisory alert resulted in termination of any active CAS-A operation. The flight crew:
    - Contacted the controller; if the flight crew was unable to contact the controller, they executed a missed approach or go-around.
    - If, when contacting the controller, the flight crew had out-the-window visual contact, they advised the controller, who could issue a visual separation instruction.

2.8 Roles and Responsibilities During CAS-A Operations

2.8.1 Air Traffic Controller

The roles and responsibilities of Approach and Tower controllers for standard FAA ATC operations where flight crews maintain pilot-applied visual separation from the TTF were equally valid for CAS-A operations. Controllers remained responsible for setting up the sequence and the inter-aircraft arrival/approach spacing so a CAS-A operation would be successful.

CAS-A operations only impacted separation from the TTF and did not affect the approach navigation clearances used. Therefore, any FAA procedures or requirements for visual or instrument approach clearances could be used during CAS-A operations. As previously stated, the only requirement for initiating a CAS-A operation was that the airport had to be VMC for runway operations (1000-foot AGL cloud ceiling and a horizontal visibility of 3 statute miles).

The controller that issued the traffic designation instruction could either be an upstream controller (e.g., a Feeder Controller) or the controller (i.e., the Final Controller) that issued the CAS-A instruction ("follow" the TTF). A controller who issued the traffic designation instruction but not the CAS-A instruction ("follow") had to coordinate and convey traffic designation status to the next controller.

A flight crew was required to have designated the TTF before a controller could issue a CAS-A instruction. In addition, before a CAS-A instruction could be issued by a controller, the CAS-A aircraft and TTF had to be:

1. Established on the final approach course; or
2. Established on an arrival procedure that connected to the final approach course; or
3. On a vector to intercept the final approach course.

The CAS-A instruction could only be issued by a controller after the issuance of the approach clearance, whether in the same or a later VHF transmission.

Before a flight crew accepted the CAS-A instruction, the controller was responsible for applying surveillance separation minima between both aircraft. After having accepted the CAS-A instruction, the flight crew became responsible for following the TTF at a reasonable distance and the controller was no longer responsible for maintaining surveillance separation minima between the aircraft conducting a CAS-A operation and the TTF. The controller remained responsible for providing separation between the aircraft conducting a CAS-A operation and all other aircraft (except the TTF) for which the controller had separation responsibility. The Tower controller was still responsible for runway separation and issuing landing clearances for all aircraft.

A controller responsibility that exists in standard FAA ATC operations and remained in effect for CAS-A operations was the issuance of safety alerts. Two paragraphs of FAA JO 7110.65AA[19] applied to safety alerts.

Para. 2−1−2. DUTY PRIORITY

Give first priority to separating aircraft and issuing safety alerts as required in this order. Good judgment must be used in prioritizing all other provisions of this order based on the requirements of the situation at hand.

Para. 2−1−6. SAFETY ALERT

Issue a safety alert to an aircraft if you are aware the aircraft is in a position/altitude that, in your judgment, places it in unsafe proximity to terrain, obstructions, or other aircraft. Once the pilot informs you action is being taken to resolve the situation, you may discontinue the issuance of further alerts. Do not assume that because someone else has responsibility for the aircraft that the unsafe situation has been observed and the safety alert issued; inform the appropriate controller.

Note−

1. *The issuance of a safety alert is a first priority (see paragraph 2−1−2, Duty Priority) once the controller observes and recognizes a situation of unsafe aircraft proximity to terrain, obstacles, or other aircraft. Conditions, such as workload, traffic volume, the quality/limitations of the radar system, and the available lead time to react are factors in determining whether it is reasonable for the controller to observe and recognize such situations. While a controller cannot see immediately the development of every situation*

where a safety alert must be issued, the controller must remain vigilant for such situations and issue a safety alert when the situation is recognized.

2. *Recognition of situations of unsafe proximity may result from MSAW/E−MSAW [Minimum Safe Altitude Warning], automatic altitude readouts, Conflict/Mode C Intruder Alert, observations on a PAR [precision approach radar] scope, or pilot reports.*
3. *Once the alert is issued, it is solely the pilot's prerogative to determine what course of action, if any, will be taken.*

If the flight crew conducting a CAS-A operation reported that they could no longer follow the TTF with their ASA system, the same contingency procedure used in standard operations applied. That is, after having been informed by the flight crew that they could no longer continue a CAS-A operation, the controller became responsible for providing appropriate instructions to establish another form of separation between the two aircraft (as the distance from the TTF could be less than surveillance separation minima).

As with standard FAA ATC operations, the controller needed to ensure the CAS-A operational requirements for airport weather conditions were met.

2.8.2 Flight Crew

On any flight, an AAL flight crew can designate traffic in the ASA system for general traffic awareness or to conduct a CAVS operation. When performing a CAVS operation, the flight crew takes the appropriate actions to follow the TTF at a reasonable distance. If it is no longer possible for the flight crew conducting CAVS to do so, the flight crew informs the controller as soon as possible and proceeds in accordance with the alternative instructions given by the controller. Depending on the situation, the flight crew can initiate a missed approach or go-around procedure even before informing the controller (as can occur in standard operations).

However, CAS-A operations could only be conducted if a controller provided the TTF identification to the flight crew, received verification that the TTF was designated, and issued the CAS-A instruction. The flight crew was then responsible for conducting a CAS-A operation relative to the TTF using the information on the MCDU and AGD. The flight deck procedures for CAS-A operations included the flight crew's use of their MDCU and AGD to assist in designating the TTF using its call sign and following it per operational requirements.

Separately, as in standard operations, the flight crew was responsible for notifying the controller if they could not accept an approach clearance.

The flight crew conducting a CAS-A operation took the appropriate actions to follow the TTF at a reasonable distance. If it was no longer possible for the flight crew conducting a CAS-A operation to follow the TTF at a reasonable distance, the flight crew informed the controller[19] as soon as possible and proceeded in accordance with the alternative instructions given by the controller. Depending on the situation, the flight crew could initiate a missed approach or go-around procedure even before informing the controller (as can occur in standard operations).

[19] Note that flight crew communication with a controller would be slightly different for a CAVS operation than a CAS-A operation since the controller is unaware when a CAVS operation is underway.

If it became necessary for a flight crew to discontinue a CAS-A operation due to ASA system failure or for other reasons, but maintenance of visual separation from the TTF was still possible, the flight crew could advise the controller of this[20]. In this scenario, the controller would either issue a visual separation instruction or provide other instructions.

If visual out-the-window contact with the TTF was achieved at any point in a CAS-A operation, the flight crew could use that information for traffic awareness but could not rely solely on visual out-the-window contact to conduct a CAS-A operation.

2.9 CAS-A Phraseology

This section reviews phraseology for CAS-A operations. There were no changes to phraseology related to approach clearances, so those communications are only discussed when related to a communication associated with a CAS-A operation.

2.9.1 Identification of TTF

Controllers used the call sign of the TTF when identifying that aircraft in the traffic designation instruction. The use of other information, such as distance and clock position, was at the discretion of the controller.

CAS-A operations were initiated by the traffic designation instruction which was specified in controller training. At the beginning of the operational evaluation, this traffic designation instruction was:

- Controller message: "[*CAS-A aircraft call sign*], EXPECT TO FOLLOW [*TTF call sign*], REPORT DESIGNATED"
    - Example: "American 452, expect to follow Southwest 387, report designated"

However, some D10 controllers felt this phraseology was too cumbersome and requested permission to use an alternative phrasing. In August of 2023, D10 controllers were authorized to use the following alternative phrasing for the traffic designation instruction:

- Controller message: "[*CAS-A aircraft call sign*], DESIGNATE [*TTF call sign*]" [Optional][AND REPORT]
    - Example: "American 452, designate Southwest 387"; or
      "American 452, designate Southwest 387 and report"

There was a potential for flight crews to be unaware of the three-letter designator associated with the TTF's call sign. Controllers could therefore use a phonetic or individual letter version of the call sign for clarification. (e.g., "Romeo Papa Alpha" or "R-P-A" for "Brickyard")

- Example: "American 452, designate R-P-A 3732"

[20] There is no need for a flight crew to notify a controller about CAVS-capable ASA system failures since controllers are unaware of CAVS operations.

The flight crew acknowledged with their aircraft identification, either at the beginning or at the end of their transmission and read back the Flight ID of the TTF. To minimize the use of third-party call sign confusion[21], after initial confirmation of the TTF's identification, controllers and flight crews were encouraged to further reference the TTF by using the words "designated traffic."

2.9.2 Verification of TTF

The controller was required to receive confirmation of the TTF call sign prior to issuing the CAS-A instruction ("follow"). This ensured that the flight crew had the correct TTF call sign prior to the controller being relieved of the requirement to apply surveillance separation minima.

- Flight crew message: "[*CAS-A aircraft call sign*] HAS DESIGNATED [*TTF call sign*]"
  - Example: "American 452 has designated Southwest 387"

If the flight crew did not confirm the TTF call sign during a reasonable period, the controller was required to prompt the flight crew for confirmation that they had designated the TTF.

- Controller message: "[*CAS-A aircraft call sign*], VERIFY TRAFFIC DESIGNATED"
  - Example: "American 456, verify traffic designated"
- Flight crew message: "[*CAS-A aircraft call sign*] DESIGNATED [*TTF call sign*]"
  - Example: "American 456 designated Southwest 123"

2.9.3 CAS-A Instruction

The CAS-A instruction ("follow") could not be issued by a controller until after the issuance of the approach clearance, whether in the same or in a later transmission. To avoid providing the flight crews with too much information at once, controllers used good judgement when adding the CAS-A instruction ("follow") after the approach clearance.

In standard FAA ATC operations, FAA controllers often issue a speed instruction along with a pilot-applied visual separation instruction (e.g., "…follow the Southwest Boeing 737, cleared visual approach Runway 33L, maintain 170 knots to…"). This is done to maintain an evenly spaced flow of traffic but is not intended to interfere with the flight crew's ability to follow the TTF. These same procedures (issue a speed instruction along with the approach clearance and a CAS-A instruction) could be used during CAS-A operations as the controller deemed appropriate.

A CAS-A operation was directly analogous to pilot-applied visual separation, as defined in FAA Order 7110.65AA[19]. Like pilot-applied visual separation, a CAS-A operation relieved the approach controller from having to enforce the otherwise-applicable surveillance separation minima. The approach controller monitored the CAS-A operation and provided speed instructions to the flight crew as the controller deemed necessary. At the beginning of the operational evaluation, this traffic designation instruction was:

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[21] Third party call sign confusion happens when the flight crew of another aircraft (e.g., the TTF) hears their own call sign in a communication and wonders whether they were being addressed (versus spoken about). For example, if the flight crew of Southwest 387 hears their call sign in the traffic designation instruction, they may ask the controller if the communication was for them. See also [22].

- Controller message with approach clearance: “[*CAS-A aircraft call sign*], [*Approach Clearance*], FOLLOW DESIGNATED TRAFFIC”
    - Example with instrument approach clearance:
      “American 452, turn left heading 200, maintain 3000 until established on the localizer, cleared ILS Runway 17L approach, follow designated traffic”
    - Example with visual approach clearance:
      “American 452, turn left heading 200, join the localizer, cleared visual approach Runway 17L, follow designated traffic”
- Controller message: “[*CAS-A aircraft call sign*], FOLLOW DESIGNATED TRAFFIC”
    - Example: “American 452, follow designated traffic”

However, as previously mentioned in Section 2.9.1, some D10 controllers felt this phraseology was too cumbersome and suggested shortened phraseology. In August of 2023, D10 controllers were authorized to use the following phraseology for the CAS-A instruction (follow):

- Controller message with approach clearance: “[*CAS-A aircraft call sign*], [*approach clearance*] FOLLOW TRAFFIC”
    - Example with instrument approach clearance:
      “American 452, turn left heading 200, maintain 3000 until established on the localizer, cleared ILS Runway 17L approach, follow traffic”
    - Example with visual approach clearance:
      “American 452, turn left heading 200, join the localizer, cleared visual approach Runway 17L, follow traffic”
- Flight crew message with approach clearance: “[*CAS-A Aircraft call sign*], [*Approach Clearance*] FOLLOW [or FOLLOWING] TRAFFIC”
    - Example with instrument approach clearance:
      “American 452, heading 200, maintain 3000 until established, cleared ILS Runway 17L, follow traffic”
    - Example with visual approach clearance:
      “American 452, heading 200 to join the localizer, cleared visual approach Runway 17L, follow traffic”

- Controller message: “[*CAS-A aircraft call sign*] FOLLOW TRAFFIC”
    - Example: “American 452, follow traffic”
- Flight crew message: “[*CAS-A aircraft call sign*], FOLLOW [or FOLLOWING] TRAFFIC”
    - Example: “American 452, follow traffic”

Controllers and flight crews were allowed to use the term “designated” in association with “traffic” when issuing or responding to the CAS-A instruction (follow) if desired for clarity or emphasis (e.g., “…follow designated traffic.”). In the context of the CAS-A instruction, “follow traffic” allowed flight crews to transition through IMC conditions only when the TTF had previously been designated.

2.9.4 Abnormal Cancellation or Rejection

While rare, there were times when a flight crew needed to reject a CAS-A instruction (e.g., report "unable") or discontinue an ongoing CAS-A operation. In addition, a controller could cancel an ongoing operation. In either case, the controller issued alternate control instructions. The sections below contain the phraseology used in those events.

2.9.4.1 Rejection by the Flight Crew

Flight crews could reject a controller instruction during the Traffic Identification phase or when the CAS-A instruction was issued. This could be due to late delivery of instructions from the controller, flight crew prerogative, or the inability of the ASA system to display the TTF on the AGD (including if TTF designation was rejected by the ASA system).

- Controller message: "[*CAS-A aircraft call sign*] DESIGNATE [*TTF call sign*]"
  - Example: "American 452, Designate Southwest 387"
- Flight crew message: "UNABLE, [*CAS-A aircraft call sign*]"
  - Example: "Unable, American 452"

2.9.4.2 Abnormal Cancellation Initiated by a Flight Crew

After the initiation of a CAS-A operation, a flight crew could report that they were unable to continue with the operation or had an ASA system failure. For example, when a flight crew was unable to monitor the designated traffic on the AGD, the flight crew informed a controller. If a flight crew deemed the inability to monitor the designated traffic on the AGD to be a temporary condition, they could inform a controller of the cause using plain language. The flight crew could also optionally communicate the reason. The controller then issued alternate control instructions.

- Flight crew message: "UNABLE TO FOLLOW DESIGNATED TRAFFIC. [Optional reason]. [*CAS-A aircraft call sign*]."
  - Example: "Unable to follow designated traffic. Traffic lost. American 452"
- Controller message: "[*CAS-A aircraft call sign*], [*alternate control instructions*]"
  - Example: "American 452, reduce to final approach speed"

2.9.4.3 Abnormal Cancellation by a Controller

If a controller had to cancel an ongoing CAS-A operation, the controller issued the cancellation instruction and alternate control instructions.

- Controller message: "[*CAS-A aircraft call sign*], DISREGARD DESIGNATED TRAFFIC, [*alternate control instructions*]"
  - Example: "American 452, disregard designated traffic, reduce speed to 170 knots"

2.10 Training

Training was required for AAL flight crews prior to CAVS operations. Training was required for both AAL flight crews and D10 controllers prior to authorization of CAS-A operations. The sections below provide a summary of the training conducted.

2.10.1 Pilot Training

All AAL Airbus single-aisle aircraft (A321, A320, and A319) flight crews completed distance-learning (DL) computer-based training (CBT) for CAVS[22] prior to FAA operational approval in May 2021. All AAL Airbus single-aisle aircraft flight crews completed DL CBT for CAS-A operations prior to commencement of the operational evaluation. The training material covered topics such as the following.

- SafeRoute+ system features and their use for CAVS/CAS-A operations
- The CAVS and CAS-A concepts
- The weather requirements to conduct CAS-A operations
- Flight crew actions
- Flight crew and controller roles and responsibilities
- Phraseology
- Contingencies

Pilots also had access to a CAS-A quick reference guide on their company-issued iPads.

AAL also published additional information about CAS-A operations in the form of Crew Check In (CCI) memos during the operational evaluation period. These CCI memos included messages to reinforce training material and/or update flight crews on areas of special emphasis.

2.10.2 Controller CAS-A Training

D10 controllers were initially trained via briefing and simulation sessions before the CAS-A operational evaluation began. The briefing covered the following topics.

- The CAS-A concept
- The weather requirements to conduct CAS-A operations
- Controller and flight crew roles and responsibilities
- Phraseology
- The ASA system used by AAL flight crews
- ASA system alert functions and recovery from a failed CAS-A operation

The controller simulation sessions involved watching a demonstration of CAS-A operations followed by each approach controller running CAS-A operations in the D10 Enhanced Target Generator (ETG) lab. The ETG is an environment that simulates a TRACON control room with STARS equipment, and includes multiple controller stations, simulated traffic, and voice communications via "pseudo-pilots." The ETG is used to train controllers on different techniques and procedures in a realistic setting but without live traffic. To ensure familiarization, all D10 controllers participated in simulation sessions on two separate occasions prior to the start of the operational evaluation.

D10 conducted a refresher briefing for all approach controllers in August 2023 which reviewed some of the material from the initial briefing and which briefed controllers on phraseology changes/alternatives based on their feedback.

[22] See FAA AC 90-114C[18], Appendix B for guidance on the content of such training.

D10 controllers had access to a CAS-A "cheat sheet" at their control positions reminding them of the operation and the phraseology. D10 controllers also had access to feedback sheets if they had interest in providing feedback on a particular CAS-A operation. Another feedback form was available during weekly D10 controller team briefings for more information on CAS-A operations and suggestions. Occasionally, AAL pilots (both management and union) attended D10 controller team briefings to discuss CAS-A operations with controllers, get feedback, and share information on CAS-A operations.

2.11 CAS-A Operational Evaluation Safety Risk Management Activities

Safety Risk Management (SRM) work was conducted before the CAS-A operational evaluation. An SRM panel was convened January 11-12, 2022 to identify and assess hazards associated with the proposed CAS-A operational evaluation in D10 airspace. The panel was comprised of stakeholders representing the FAA Flight Standards Service, FAA Air Traffic Organization (ATO) (including Air Traffic Services, Mission Support Services, and Program Management Organization), D10, NATCA, APA, and AAL management and flight operations. The panel included SMEs in air traffic operations, ASAs, flight operations, and safety. The assessment was conducted in accordance with the FAA Air Traffic Organization (ATO) Safety Management System (SMS) Manual dated April 2019[23].

The SRM panel identified one hazard with four effects. The hazard, "Designate the wrong TTF," was defined when either the flight crew or the controller mistakenly identified or designated an incorrect TTF. Several controls were identified to minimize the severity of impacts, leading to all effects having a severity rating of 5 (Minimal) and 4 (Minor). All four effects were found to be Low risk. Table 1 below summarizes the identified hazard and effects.

Table 1 – Summary of Identified Hazards

Hazard Title	Effect	Initial Risk & Predicted Residual Risk
Designate the wrong TTF	CAS-A aircraft and TTF are too close to apply runway separation	Severity: 5 – Minimal Likelihood: D – Extremely Remote Risk: Low
	Increased communication/ increased workload	Severity: 5 – Minimal Likelihood: C – Remote Risk: Low
	Loss of situational [i.e., situation] awareness on flight deck	Severity: 5 – Minimal Likelihood: C – Remote Risk: Low
	Loss of separation with another aircraft[23]	Severity: 4 – Minor Likelihood: D – Extremely Remote Risk: Low

[23] Note that the worst hazard effect was considered by the SRM Panel to be an aircraft not engaged in a CAS-A operation closing from behind on a CAS-A aircraft (e.g., because the CAS-A aircraft quickly slowed due to incorrect information being provided by the ASA system in response to wrong TTF designation).

The SRM panel reviewed an operational description[24] as part of the hazard assessment and provided input to assist D10 in finalizing their Standard Operating Procedures (SOPs) and phraseology.

The SRM panel results were documented in a Safety Risk Management Document (SRMD) which was reviewed and approved in December 2022, as shown in Appendix 9.5.

2.12 AIRS Project Team Coordination Activities

The AIRS project was a public-private partnership that included collaboration between the FAA, AAL, ACSS, NATCA and APA. Due to the collaborative and multi-organizational nature of this work, significant coordination and communication was required to successfully conduct the project.

Since CAVS operations and the CAS-A operational evaluation were conducted using certified aircraft operating in revenue service, all equipment and procedures were coordinated within the AIRS team and approved by appropriate FAA organizations prior to the start of the operations. Significant data collection and analysis efforts were required by all parties to achieve the goals of evaluating the operational feasibility of CAS-A operations and understanding the value of CAVS and CAS-A operations.

AIRS team reviews were held to identify any operational safety concerns, gain insights into the operations from data collected and analyzed, and determine if any changes could be made to improve operations. These reviews included insights from controllers, flight crews, and experts in ASA systems, procedures, and other aspects of CAVS and CAS-A operations.

AIRS team reviews were conducted through virtual and in-person meetings. When the CAS-A operational evaluation began, virtual meetings were held weekly, but as the operational evaluation matured, the frequency was reduced to bi-weekly. The virtual meetings provided a status of recent CAS-A operations and timely insights into any issues identified. After the initiation of the CAS-A operational evaluation, in-person meetings were hosted by D10 and were held monthly, but as the operational evaluation matured, the frequency of these meetings was reduced to bi-monthly. The in-person meetings were used to provide a more comprehensive review of the CAS-A and CAVS operations data. During these meetings, AIRS team members examined trends in the data, conducted detailed reviews of key operations, and developed solutions for any observed issues.

2.13 Aircraft Equipage and Flight Crew Experience with CAVS and CAS-A Operations

As shown in Figure 15, when AAL was approved to begin CAVS operations, less than 50 AAL A321 aircraft were equipped with the ASA system that enabled such operations. Given that there

[24] The operational description reviewed by the SRM panel was an earlier version of [24]. Beyond the addition of text explaining controller responsibilities to readers unfamiliar with FAA JO 7110.65 when pilot-applied visual separation is applied, other text clarifications resulting from the SRM Panel process, and subsequent AIRS team discussions, there were no substantive changes made to the operational description submitted to the SRM panel.

were approximately 180 A319/A320 in the AAL fleet at that time, this meant that there was an average pilot exposure probability[25] of less than 10%.

By the start of the CAS-A operational evaluation on March 1, 2023, 242 of the 288 AAL A321ceo and A321neo aircraft were equipped with the SafeRoute+ system and the average pilot exposure probability was 52%. By January 2024, all 288 AAL A321 aircraft flying at the time were equipped and the average pilot exposure probability exceeded 61%. In the first half of 2024, AAL acquired an additional 10 A321neo aircraft and the SafeRoute+ system was installed in those aircraft, bringing the total to 298 equipped aircraft and increasing the average pilot exposure probability to 62%. Note that this exposure probability was only with respect to the ASA system which permitted CAVS operations – it did not address the probability of receiving a CAS-A instruction from a D10 controller.

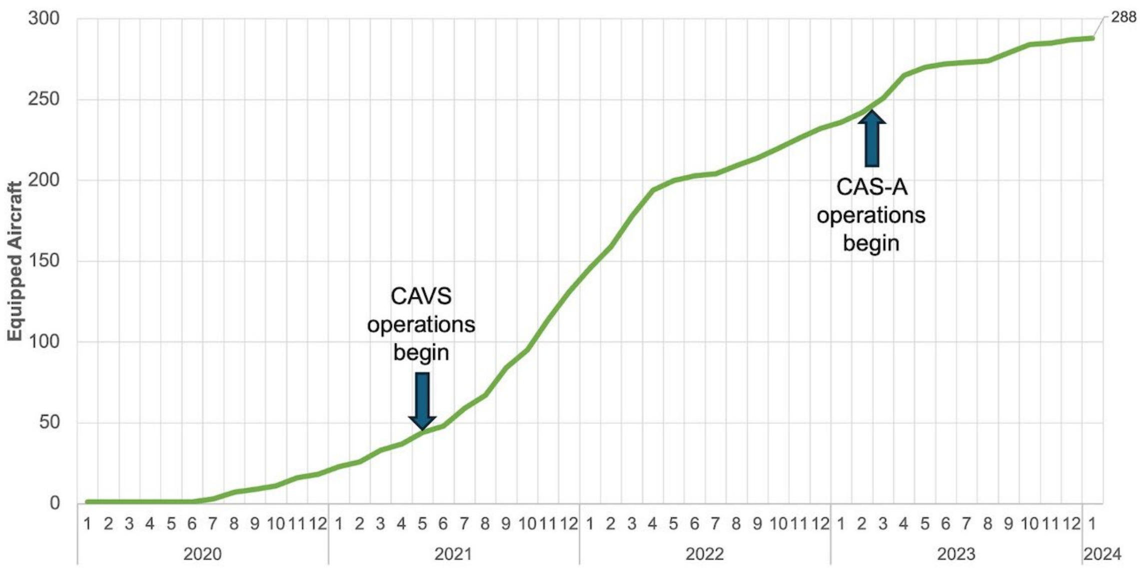

Figure 15 – A321 Equipage During the Operational Evaluation

During the CAS-A operational evaluation, AAL had over 6,000 pilots qualified on the AAL single-aisle Airbus fleet (A321 as well as A319 and A320) of approximately 480 aircraft. Therefore, the odds of a given pilot conducting a CAS-A operation were relatively low because that pilot would need to be in an aircraft equipped with the ASA system, arriving at DFW, in a situation where a CAS-A operation could be utilized, and in an aircraft where a D10 controller decided to utilize a CAS-A operation when the opportunity arose. Conversely, less than 70 controllers worked arrivals at D10 during the operational evaluation. Therefore, AAL Airbus single-aisle flight crew members had fewer opportunities to experience a CAS-A operation than the much smaller number of controllers working at D10.

[25] This was defined as the number of A321ceo and A321neo aircraft equipped with the SafeRoute+ system, divided by the total number of Airbus single-aisle aircraft in operation by AAL during the period.

3 Data Sources, Collection Methods, and Analyses Approaches

Data was collected to understand utilization of CAVS/CAS-A operations and quantifiable impacts, as well as to assess CAS-A operations from the perspectives of participating controllers and pilots. The data sources used, the collection methodology, and approach to the analyses are covered in this section.

3.1 Overall Approach to Data Collection and Use of Data

To provide for regular monitoring of CAS-A operations, the process shown in Figure 16 was used.

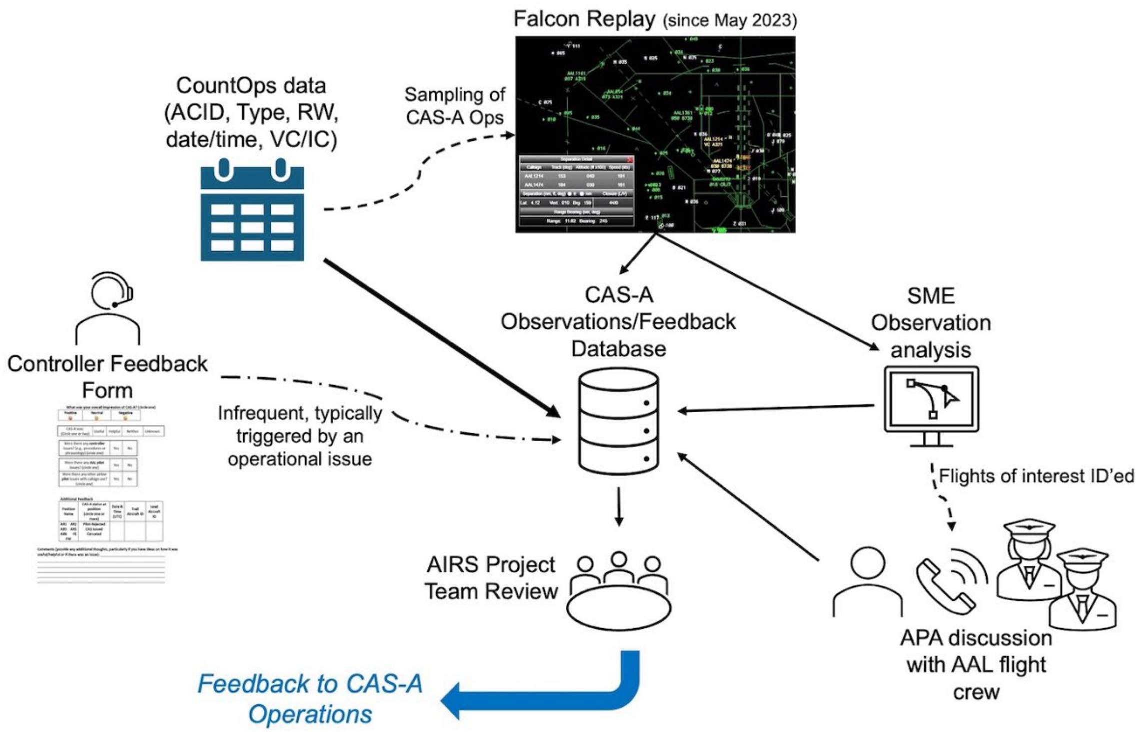

Figure 16 – Data Collection/Analysis process for providing feedback to CAS-A operations

CAS-A operations data collection processes were initiated by CountOps data from the FAA Operational Network (OPSNET)[26]. CountOps was the authoritative source for when a CAS-A operation had occurred; see section 3.2 for further information. CountOps data was downloaded and distributed to the AIRS team every week.

Beginning in May 2023, groupings of CAS-A operations were identified for Falcon replay recording when approximately five[27] or more CAS-A operations occurred in an hour. However, there were weeks when no hours met the criteria. In those cases, Falcon replay recordings would be made of available operations. CountOps data also showed hours that included one or two CAS-A operations. Since those operations had the potential to be different (i.e., if there were

[26] See https://www.aspm.faa.gov/opsnet/sys/main.asp.
[27] The AIRS team determined that five CAS-A operations per hour justified the effort required to make a Falcon replay recording.

several opportunities to conduct CAS-A operations but only one occurred), such operations were also sampled for Falcon replay recording on a regular basis. Similarly, instrument approach CAS-A operations occurred much less frequently than visual approach CAS-A operations, so instrument approach CAS-A operations were also sampled for Falcon replay recording when they did not meet the hourly criteria. All Falcon replay recordings were reviewed by an AIRS team SME, who would fill out a CAS-A observation form, as described in Section 3.4.

Depending on what was observed in Falcon replay recordings, the AIRS team SME could contact the APA representative on the AIRS team (indicated by the dashed curved line in the figure) and suggest discussion with the AAL flight crew[28] of a given CAS-A operation. If such a discussion occurred, the APA representative would fill out an APA Pilot Feedback Form for inclusion in the CAS-A observations/feedback database; see Section 3.5 for further information.

A controller feedback form was available to any D10 controller who chose to provide feedback for any reason. These forms were typically submitted when there was a situation that needed to be addressed or brought to the AIRS team's attention. After the first weeks of the operational evaluation, such submissions were very infrequent, as indicated by the dashed line in Figure 16. When a D10 controller submitted a form, they were collected by other D10 personnel and provided to the AIRS team SME managing the CAS-A observations/feedback database for entry and analysis; see Section 3.6 for further information.

Some additional methods were needed to gather data on potential or attempted CAS-A operations that did not appear in CountOps data. Beginning on March 20, 2023, when a D10 controller issued either a traffic designation instruction or a CAS-A instruction (follow) and the flight crew responded as "unable", the controller could make a ZP entry[29] in STARS to mark the "unable" event. This method of capturing unable events was necessary because if traffic designation did not occur, there was no other record of a controller's attempt to initiate a CAS-A operation. As shown in Figure 17, a list of ZP unable events was collected by D10 personnel and periodically provided to the AIRS team for entry in the CAS-A observations/feedback database. For all ZP unable events, a Falcon replay recording was made and reviewed by an AIRS team SME (who would fill out a CAS-A observation form); also, APA was notified and requested to interview at least one flight crew member from that flight.

[28] With the AAL flight number and date from the CAS-A observations/feedback database, APA could locate such personnel within the company without any further involvement from the AIRS team.
[29] The ZP function was a pre-existing capability within STARS that allowed controllers to mark events for follow up by facility technicians or facility management.

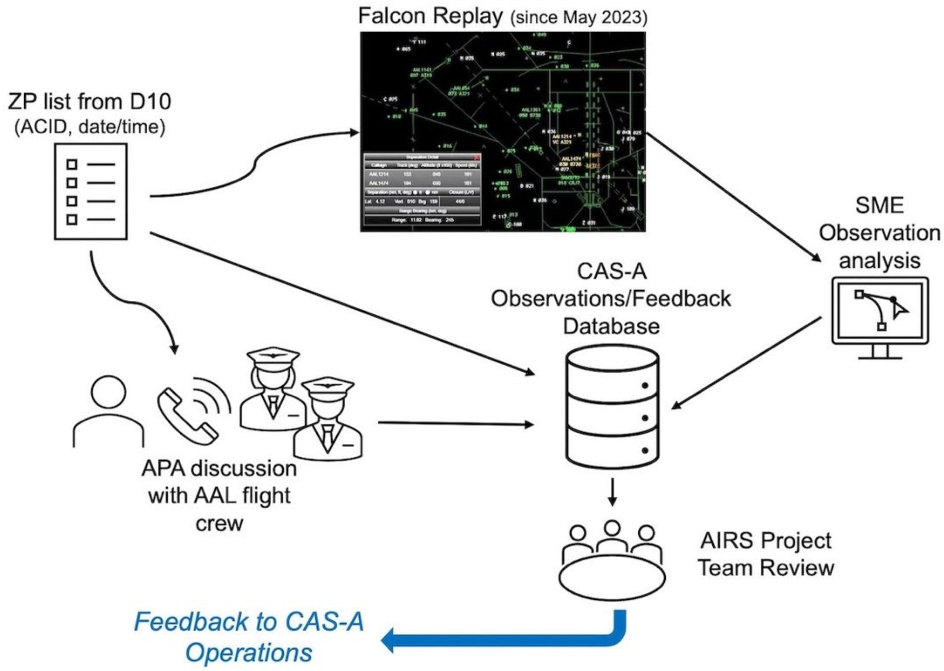

Figure 17 – Data Collection/Analysis process for Flight Crew CAS-A unable events

An additional data collection subprocess was needed to determine if a go-around or missed approach occurred because of a CAS-A operation. This process was needed since CountOps only recorded operations which ended in a landing, but during a go-around/missed approach, the STARS scratchpad entries for an aircraft were cleared. Therefore, a separate data collection was used, as shown in Figure 18. The FAA's Performance Data Analysis and Reporting System (PDARS) was used, as described in Section 3.7, to generate a go-around report for DFW, which included the Aircraft ID, the aircraft type, landing runway and date/time. This report would be filtered to just show a listing of AAL aircraft with an A321 type designator[30] and used to obtain a Falcon replay of the go-around/missed approach. A Falcon replay recording was made for any such go-around/missed approach which was preceded by a CAS-A operation ("VC" or "IC" in the STARS scratchpad) and provided to the AIRS team SME for analysis. As appropriate, the AIRS team SME would notify the APA representative regarding any operation of interest – any interview outputs would be provided back to the CAS-A observations/feedback database using the APA Pilot Feedback Form.

[30] After all AAL Airbus 321s were equipped, the filter was expanded to include the A21N type designator.

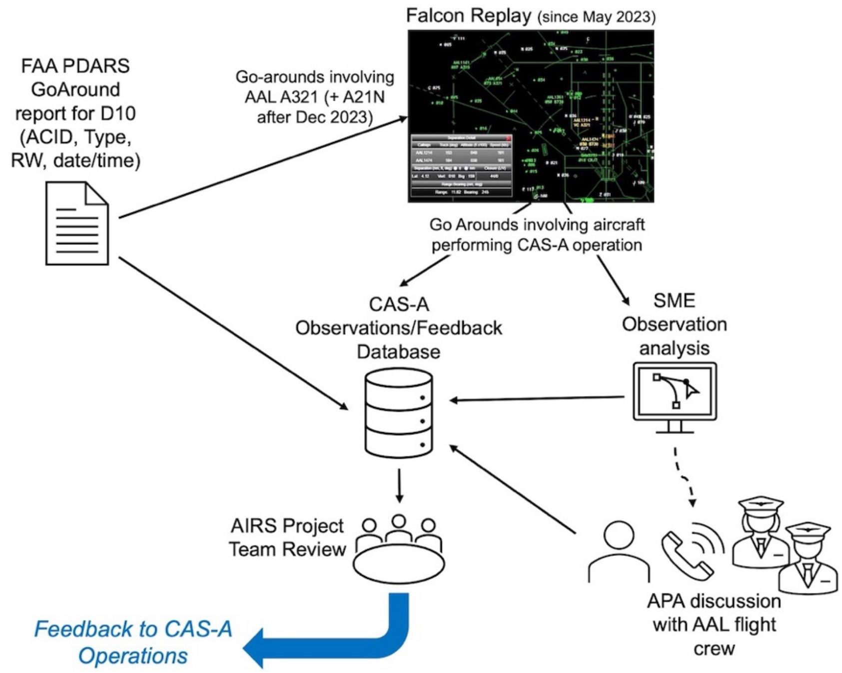

Figure 18 – Data Collection/Analysis process for AAL A321/A21N Go-Arounds at DFW

All information gathered by these methods were recorded in the CAS-A observations/feedback database to build a more complete picture of CAS-A operations, which was then continuously reviewed by the AIRS team and which provided feedback to the operational evaluation. Such feedback led to controller training updates, flight crew training updates, and changes in the phraseology used by controllers and flight crews during CAS-A operations.

Additional data was collected during the operational evaluation, as shown in Figure 19. The SafeRoute+ system recorded onboard data on a Compact Flash (CF) card. See Section 3.9 for further information. It took months from the date when a CAVS/CAS-A operation occurred until the data could be processed and analyzed by the AIRS team. From the aircraft data, "Traffic Designation events" were identified, as described in Section 3.9, and then correlated with other data sources, as shown in Figure 19. To determine traffic designation by destination airport (see Section 3.11.1), Traffic Designation events were correlated with FAA Aviation System Performance Metrics (ASPM) (see Section 3.10) information on the arrival airport for each flight. To determine traffic designation within 25 NM of six AAL hub airports (see Section 3.11.2), to support the Inter-Arrival Time (IAT) and Inter-Arrival Distance (IAD) analysis (see Section 3.11.3) and the terminal area flight time/distance analysis (see Section 3.11.4), Traffic Designation events were correlated with ASPM information on airport ceiling/visibility, arrival tracks into airports of interest from the Instrument Flight Procedures (IFP), Operations, and Airspace Analytics (IOAA) Tool (see Section 3.8), and CountOps data on CAS-A operations (see Section 3.2).

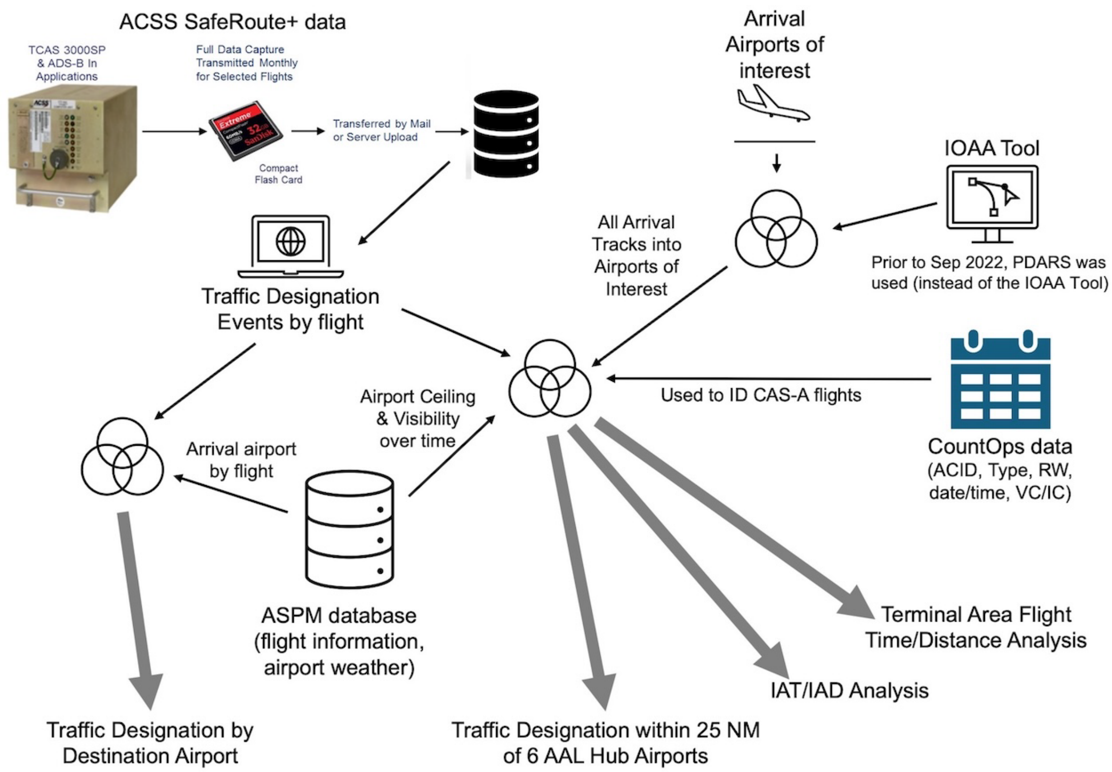

Figure 19 – Correlating data sources for CAVS/CAS-A Analyses

3.2 CountOps to Determine When CAS-A Operations Occurred

CountOps is an FAA automated system that utilizes data from STARS to provide hourly counts of air traffic activity at TRACONs, towers, and airports. It includes counts for more than 2,000 towers and airports[31]. CountOps also contains information on individual arrival and departure operations by hour and detail on individual records.

For the CAS-A operational evaluation, CountOps Detail Reports[32] were particularly useful because they contained STARS scratchpad information for individual flights. As noted earlier, D10 used the scratchpad to indicate a CAS-A operation by entering either the code "IC" or "VC." The AIRS team used this information to identify and count CAS-A operations and correlate the data with flights from the IOAA trajectory data and other data sources.

3.3 Falcon Replay Recordings of CAS-A Operations

Assigned FAA members of the AIRS team created replays of CAS-A operations identified as being of interest using the FAA Falcon replay toolset. Falcon allows users to replay operations from up to 45 days prior to near real time. These replays consisted of video representing the FAA surveillance data provided to STARS, relevant STARS data block information, and audio of controller and pilot communications. Figure 20 shows a screenshot from a sample Falcon replay

[31] See https://aspmhelp.faa.gov/index/CountOps_Manual.html. (Data retrieved March 2023 through February 2025)
[32] See https://aspmhelp.faa.gov/index/CountOps__Detail_Report.html

recording of AAL1214 conducting a CAS-A operation on approach to DFW, with AAL1474 as the TTF in this sample.

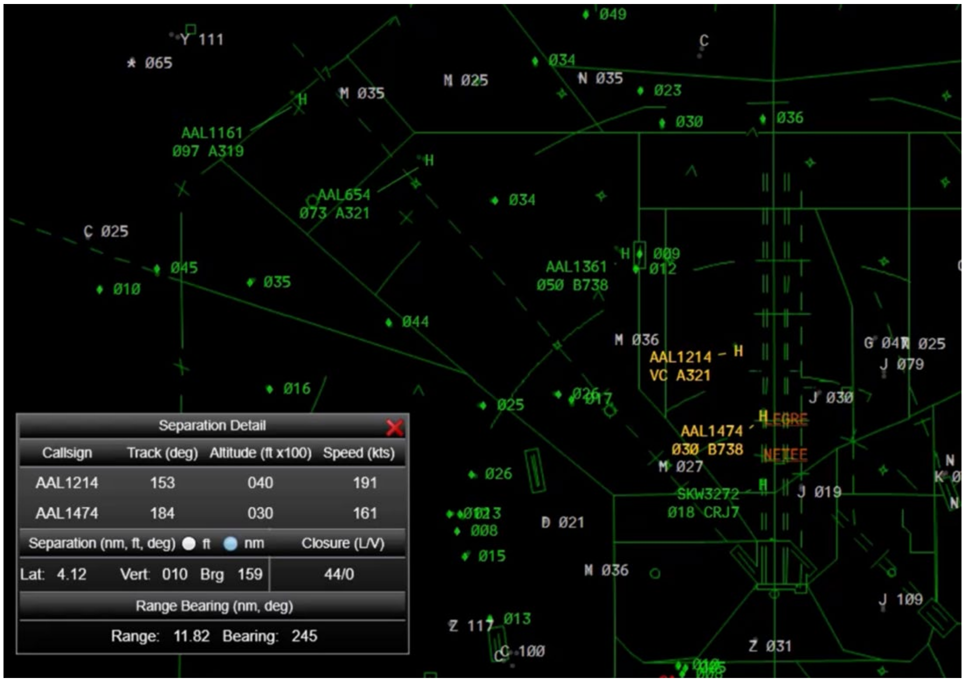

Figure 20 – Sample Falcon screenshot showing AAL1214 conducing a CAS-A operation

For Falcon replay recordings, operations were identified for review based on an hourly log of CAS-A operations from CountOps. Section 3.1 describes how CAS-A operations were identified for a Falcon replay recording. Once a CAS-A operation or an arrival period of interest was identified, an assigned FAA employee would access the operation(s) in the Falcon replay toolset and capture a recording of the audio and video using audiovisual capture software.

Falcon replay recordings helped the AIRS team understand various aspects of the CAS-A operations, as described in section 3.4.

3.4 CAS-A Operational Observations

Of the total number of CAS-A operations that occurred during the operational evaluation (as recorded from VC/IC entries in CountOps), a subset of CAS-A operations was reviewed by an AIRS team SME and their observations were logged in the CAS-A observations/feedback database. The method for selecting and reviewing the subset of CAS-A operations is reviewed in this section. AIRS team SME observations were made only of CAS-A operations and controller feedback was only obtained for CAS-A operations. Pilot feedback was focused on CAS-A operations, but broader questions about use of the ASA system were also asked of pilots. The CAS-A observations/feedback database was populated through one or more of the methods[33] noted below.

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[33] AAL also provided an email link for direct flight crew feedback and a provision where pilots could self-submit flight crew feedback forms on pilot iPads. However, no information from these sources was recorded in the database.

- Observations of CAS-A operations by an AIRS team SME
- Direct pilot feedback interviews conducted by APA Safety representatives
- Air traffic controller feedback through self-submitted event feedback forms and ZP reports of pilot "unables"

Initial observations of CAS-A operations were conducted by AIRS team SMEs at D10 in the first few weeks of the operational evaluation. Subsequent AIRS team SME observations were conducted while watching Falcon replay recordings of CAS-A operations. Watching Falcon replay recordings allowed AIRS team SMEs to review operations without having to be at the D10 facility. Also, since the recordings could be paused, rewound and repeatedly replayed, AIRS team SMEs could more fully document their observations (compared with live observations). An observation form (see Section 9.1) was completed with details of an observed CAS-A operation. The form evolved in minor ways (e.g., adding a field for a new topic) over the course of the operational evaluation as a new topic, or detail, became of interest to the AIRS team.

In several cases, an AIRS team SME observation of a CAS-A operation would lead to a request that APA have a discussion with one of the flight crew members. When this occurred and a flight crew member had a discussion with an APA representative, notes from that discussion would be recorded by the APA representative on a pilot feedback form (see Section 9.2). If a Falcon replay recording was triggered by a controller feedback form (see Section 9.3) or a ZP event (as described in Section 3.1), then any AIRS team SME observation would be correlated with that triggering input in the CAS-A observations/feedback database.

All the AIRS team SME observations were captured in an Excel database. A database entry could be logged if there was at least an attempt by a controller to have a flight crew designate a TTF. Some observations may have ended at that point, some observations continued until the CAS-A operation ended prematurely, but most attempted CAS-A operations were completed. An individual CAS-A operation may have data from only one source or all the sources, depending on which forms were completed. However, most data in the CAS-A observations/feedback database was obtained from AIRS team SME observations of Falcon replay recordings.

Finally, over the course of the operational evaluation, new topics or details became of interest to the AIRS team and started to be tracked (mostly in the observation forms). Where data on a topic was not collected from the beginning of the operational evaluation, the start date of data collection was noted.

3.5 Pilot Feedback

Flight crew feedback was received by APA personnel interviewing pilots involved in an identified CAS-A operation. Interviews were conducted on a workload permitting basis and could include a variety of operation types (e.g., "unabled" or completed CAS-A operations). Interviews could be initiated by APA personnel based on information APA had about an operation or by an AIRS team SME bringing a particular CAS-A operation to APA's attention. The purpose of these interviews was to gather subjective feedback from flight crews on topics like their general experience when conducting a CAS-A operation, the phraseology, the use of the ASA system, and training. Most CAS-A operations were identified for interviews based on the need to fix a potential issue or to gain further information on an operation of interest. Therefore, abnormal or problematic operations are overrepresented in the data. This rationale and method of conducting interviews was based on the limited time available for APA personnel to conduct interviews and the need to resolve any issues in the operational evaluation. In addition to the questions about CAS-A operations, pilots were also asked a set of questions related to their broader use of the ASA system.

To obtain feedback, APA personnel contacted pilots via text message to request a feedback interview for a specific operation. Pilots had the option of accepting or declining participation in a discussion. Most pilots accepted the offer and were supportive of providing feedback. Once a pilot accepted, APA personnel would connect with that pilot and ask a series of questions from a feedback form developed by the AIRS team (see Section 9.2). When de-identified feedback forms were completed, they were provided to the AIRS team SME managing the CAS-A observations/feedback database for entry and analysis. The information received from these interviews was a combination of direct quotes from pilots, summarizations by the interviewer, and comments by the interviewer. The results of these interviews were also briefed to and discussed with the AIRS team during in-person meetings. APA personnel also attended several D10 controller team briefings and provided direct feedback from the pilot interviews to help the D10 controllers understand pilot perspectives.

3.6 Controller Feedback on CAS-A Operations

Air traffic control feedback was received from individual controllers at D10 who initiated an operation and chose to provide feedback for any reason via a feedback form (see Section 9.3). As with the flight crew data, the forms were likely submitted when there was a situation that needed to be addressed or brought to the attention of the AIRS team. Therefore, abnormal or problematic operations are overrepresented in this data, as well.

As described in Section 3.1, the other feedback received from controllers was a manual flagging of flight crew unable events via a "ZP" entry when the controller was actively working traffic and attempting to initiate a CAS-A operation.

In November 2024, directed discussions with D10 controllers were accomplished in two ways: via crew breakouts and while monitoring operations in the control room. Crew breakouts were held on the fourth day of the workweek and were used to either give briefings on various topics or for discussion about other issues that concerned controllers, or both. AIRS team representatives also monitored control room operations and would query controllers and supervisors regarding CAS operations when an opportunity arose.

Over the course of the operational evaluation, APA hosted numerous "Breakroom Lunch Discussions" with D10 controllers to more directly interact and discuss CAS-A operations. D10 controller weekly team briefings were periodically attended by APA representatives for similar dialogue and information exchange. These interactions were not documented.

There was a difference in experience levels between individual AAL pilots and D10 controllers that should be considered when comparing the flight crew feedback and controller feedback regarding CAS-A operations. Based on the number of AAL flight crew members of Airbus single-aisle aircraft and the number of opportunities for CAS-A operations, it was very likely an individual pilot had seen far fewer CAS-A operations than a D10 approach controller, as discussed in Section 2.13.

3.7 Performance Data Analysis and Reporting System (PDARS)

PDARS is an FAA integrated performance measurement tool that facilitates operational analysis to improve the NAS. PDARS was used to generate a periodic (weekly to monthly) go-around report for DFW[34]. This go-around report was used to identify operations to be further examined using the FAA's Falcon replay system. PDARS was also used as a secondary source for STARS scratchpad data to verify CAS-A operations at D10 were being fully captured by CountOps.

3.8 Instrument Flight Procedures, Operations, and Airspace Analytics Trajectory Data

The Instrument Flight Procedures (IFP), Operations, and Airspace Analytics (IOAA) Tool provides analysis capabilities to study flight operational metrics and implementation and use of IFP.[35] It enables analysis of fused operational usage metrics (e.g., arrival procedure usage), aircraft performance metrics (e.g., climb gradient distributions, final approach deviations), and weather conditions at various points of interest in the NAS. Users can dynamically filter parameters within the tool to correlate between metrics and identify flights of interest. The fused surveillance data used to derive operational usage, safety, and aircraft performance metrics is available for both display and download.

The historical track data, available via the IOAA tool, is fused from FAA surveillance data sources including radars, Wide-Area Multilateration (WAM) systems, airport surface surveillance systems, and ADS-B data to create a smoothed, end-to-end trajectory for each flight. The trajectory data undergoes multiple quality checks before release. For analyses of CAVS/CAS-A operations, this trajectory data was downloaded to examine individual flight profiles for all arrivals into six AAL hub airports: CLT, DFW, LAX, Miami International Airport (MIA), PHL, and PHX.

3.9 SafeRoute+ Data

SafeRoute+ data refers to parameters recorded within an ACSS TCAS unit, including parameters related to surrounding ADS-B traffic, the aircraft conducting CAVS/CAS-A (ownship), and the ASA system. SafeRoute+ data was used to identify flights where Traffic Designation events occurred and provided other useful information.

Figure 21 shows the process that ACSS developed to obtain SafeRoute+ data from equipped AAL aircraft using a CF card placed in each aircraft's TCAS unit. AAL maintenance retrieved the CF card from each TCAS unit periodically and inserted a blank CF card in its place. AAL

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[34] See https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/perf_analysis/perf_tools for more details about PDARS.
[35] FAA, the IFP, Operations, and Airspace Analytics (IOAA) tool, Airspace Usage Module. (Data retrieved January 2022 through February 2025)

maintenance then uploaded retrieved CF card data to an ACSS server for processing, typically twice a month. Note that since hundreds of aircraft were involved, data from only a subset of all AAL A321 aircraft were received in every semi-monthly data transfer.

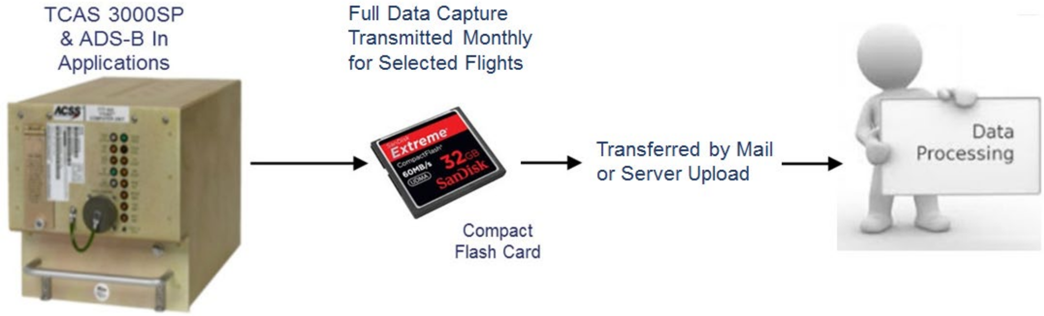


Figure 21 – Process to Obtain SafeRoute+ Data from Aircraft

Upon receiving the CF card data, ACSS used the following process:

1. Download the raw data files from the CF cards for storage and processing
2. Identify flights with Traffic Designation events
3. Calculate ASA system data parameters
4. Provide the SafeRoute+ data to the FAA semi-monthly

Based on the data extraction process, there was a lag in when a complete monthly set of data for all flights was available. The delay depended on when the data could be physically downloaded from each aircraft. In general, a complete set of data for a particular month was available to the FAA three months after the operations occurred.

Each time a flight crew designated traffic, the SafeRoute+ system recorded a single row of data containing the information in Table 2. This is referred to in this report as a Traffic Designation event.

Table 2 – SafeRoute+ Data per Traffic Designation Event

Designated Traffic Data Elements	Format
Ownship Tail Number	Tail Number
Ownship Flight ID/call sign	Three-letter call sign and number
Ownship Pressure Altitude	Pressure altitude of ownship when designation begins (feet above mean sea level [feet, MSL])
Ownship Ground Speed	Ground speed when designation begins (knots)
Designated Traffic Flight ID/call sign	Three-letter call sign and number
Designation Date Start	Date Coordinated Universal Time (UTC) (Year:Month:Day)
Designation Time Start	Time UTC (Hours:Minutes:Seconds)
Designation Time End	Time UTC (Hours:Minutes:Seconds)
Traffic Pressure Altitude	Pressure altitude of traffic when designation begins (feet, MSL)
Horizontal Range	Horizontal range from designated aircraft when designation begins (NM)

3.10 Aviation System Performance Metrics (ASPM)

ASPM is an FAA-maintained database that contains a variety of flight and airport information[36]. ASPM data falls into two categories: flight data containing information on individual flight performance and airport data containing information on airport efficiency. Data comes from an Aeronautical Radio, Incorporated (ARINC) database of Gate **O**ut, Wheels **O**ff, Wheels **O**n, and Gate **I**n (OOOI) times, Traffic Flow Management System, the U.S. Department of Transportation's Airline Service Quality Performance (ASQP) survey, weather data, airport arrival and departure rates (in 15-minute intervals), airport runway configurations, delays, cancellations, and arrival/departure rates. For this effort, data from ASPM was correlated with the ACSS data to limit analysis to aircraft call signs arriving at airports of interest, and to define different periods of meteorological conditions at the relevant airports.

3.11 Utilization and Impact Analysis Approach

The analysis included flights where the flight crews designated traffic:

- [a] at any point during a flight;
- [b] within 25 NM radius of each of six AAL hub airports (operations after May 2021 were assumed to be CAVS except for [c]);
- [c] when conducting a CAS-A operation at D10.

CAVS and CAS-A operations had some of the same benefit mechanisms. CAVS operations started in May 2021, but Traffic Designation events occurred on AAL aircraft equipped with the SafeRoute+ system prior to CAVS approval, as flight crews familiarized themselves with the ASA system. CAS-A operations started at D10 in March 2023 and concluded in February 2025. Therefore, Traffic Designation events could be analyzed for a longer time compared to the almost two years of data on CAS-A operations.

3.11.1 Traffic Designation Events (at any Point during a Flight) by Destination Airport

As described in Section 3.9, every time a flight crew designated traffic, a Traffic Designation event was recorded by the SafeRoute+ system. The AIRS data analysis team correlated the aircraft call sign, date, and time from Traffic Designation events with ASPM data to determine each flight's destination airport. Traffic Designation events were aggregated by airport and analyzed for their durations.

3.11.2 Traffic Designation Events Within 25 NM of Six AAL Hub Airports

The AIRS team correlated the aircraft call sign, date, and time from Traffic Designation events with IOAA trajectory data to determine flight destination, destination airport runway, and distance from destination airport. The data were aggregated by airport and analyses performed to determine which arrivals were had Traffic Designation events within 25 NM of each of six AAL hub airports. The AIRS team generally assumed that Traffic Designation events within a 25 NM

[36] FAA, Aviation System Performance Metrics (ASPM) Web Data System, https://aspm.faa.gov/apm/sys/main.asp (Data retrieved January 2022 through February 2024)

radius of an AAL hub airport was due to either a CAVS or CAS-A operation. There was no other means of determining when a CAVS operation occurred.

CAS-A operations were exclusively conducted at D10 for DFW arrivals. CountOps data (see Section 3.2) included a specified code ("VC" or "IC") entered in the STARS scratchpad to indicate the occurrence of a CAS-A operation. At DFW only, the monthly number and percent of equipped arrivals conducting CAS-A operations were collected metrics.

3.11.3 Inter-Arrival Time (IAT) and Inter-Arrival Distance (IAD) Analyses

On an individual aircraft basis, inter-aircraft spacing, in time and distance, at the runway threshold was used to examine the effectiveness of designating traffic and CAS-A operations. The primary metrics used for the analyses were:

- Inter-Arrival Time (IAT) – the time between the ownship[37] aircraft's threshold crossing time and TTF's threshold crossing time for the same runway.
- Inter-Arrival Distance (IAD) – the distance between the ownship aircraft and TTF when the TTF crossed the threshold of the same runway.

The IAT and IAD were calculated per arrival for all flights into six AAL hub airports from January 2022 through December 2023, and the following factors were used to group results:

- Use of the capability to designate traffic
- CAS-A operation (only if the flight was arriving at DFW airport)
- Aircraft type
- Carrier name
- Weather conditions
- Demand at the airport in terms of number of arrivals preceding the ownship aircraft during the past 15 minutes
- Weight class of Heavy for TTF aircraft, if applicable

The analysis of IAT and IAD included plotting distributions, calculating descriptive statistics (e.g., average, median, mode, and standard deviation), performing statistical tests on the difference of the averages and standard deviations, plotting average value versus demand, and performing multiple linear regression using the least squares method.

For the IAT and IAD Traffic Designation event data distribution, statistical testing, and trend analysis, the following restrictions were applied to compare relevant data unless otherwise noted:

- Limited analysis to Airbus A321 aircraft (both A321ceo and A321neo aircraft) arriving at six AAL hub airports
- Removed arrivals with IATs greater than 220 seconds
- Removed arrivals behind a Heavy category aircraft[38]
- Removed arrivals during IMC (less than 1000-foot ceiling or less than 3 miles visibility at the airport as recorded in reported weather).

[37] Ownship could have been performing either a CAVS operation (inferred from a Traffic Designation event within 25 NM of a given airport) or a CAS-A operation (as determined from CountOps data).
[38] This restriction was not applied to the data for the analysis in Section 4.2.3.2.

For the Traffic Designation event analyses, the data was filtered as outlined above and then the statistical average values, distributions, and trends were calculated within 25 NM of a given airport for three sets of aircraft:

[a] AAL A321 aircraft which designated traffic;
[b] AAL A321 aircraft that did not designate traffic;
[c] Non-AAL A321 aircraft.

Traffic Designation events within 25 NM of a given airport assumed that flight crew designation of a TTF in that environment meant the flight crew was monitoring a TTF for the approach and likely conducting CAVS (or was conducting a CAS-A operation at DFW if correlated with CountOps data). However, Traffic Designation events could have occurred for other reasons.

Regression analyses were also used to examine simultaneous impacts. For the Traffic Designation event regression analyses on IAT and IAD, the following specifications were used:

- Arrival demand (number of arrivals at the airport during the past 15 minutes)
- Arriving aircraft behind a Heavy category aircraft (0 = No, 1 = Yes)
- Air carrier (0 = non-AAL, 1 = AAL)
- Traffic Designation event within 25 NM of runway (0 = No, 1 = Yes)

Regression results included the coefficients of each independent variable, the significance of the coefficient (in terms of the P-value) and the overall goodness of fit of the model (adjusted R-Square).

At DFW, the IAT and IAD analyses were adjusted to include CAS-A operations and were very similar to the analyses performed across all six hubs. However, the date range was March 2023 through February 2025 (to capture the impacts of CAS-A operations which started in March 2023) and the sets of aircraft were limited to AAL A321 aircraft (no non-AAL A321 aircraft). The regression analyses on IAT and IAD at DFW used the following specifications:

- Arrival demand (number of arrivals at the airport during the past 15 minutes)
- Arriving aircraft behind a Heavy category aircraft (0 = No, 1 = Yes)
- Traffic designation event within 25 NM of runway (0 = No, 1 = Yes)
- CAS-A operation occurred (0 = No, 1 = Yes)

3.11.4 CAS-A Operations Impact on Flight Time/Distance for DFW Arrivals

One possible impact of decreasing IAT and IAD is a reduction in flight time or path length for the equipped aircraft and aircraft immediately behind them in the arrival stream and/or arrivals on parallel runways. The analysis focused on flight time and path length inside a ring centered on DFW with a 25 NM radius, as shown in Figure 22 with sample flight paths.

The primary metrics used were:

- Flight time – The time flown between entering a 25 NM radius ring centered on DFW and the landing runway threshold.
- Flight distance – The distance flown between a 25 NM radius ring centered on DFW and the landing runway threshold.

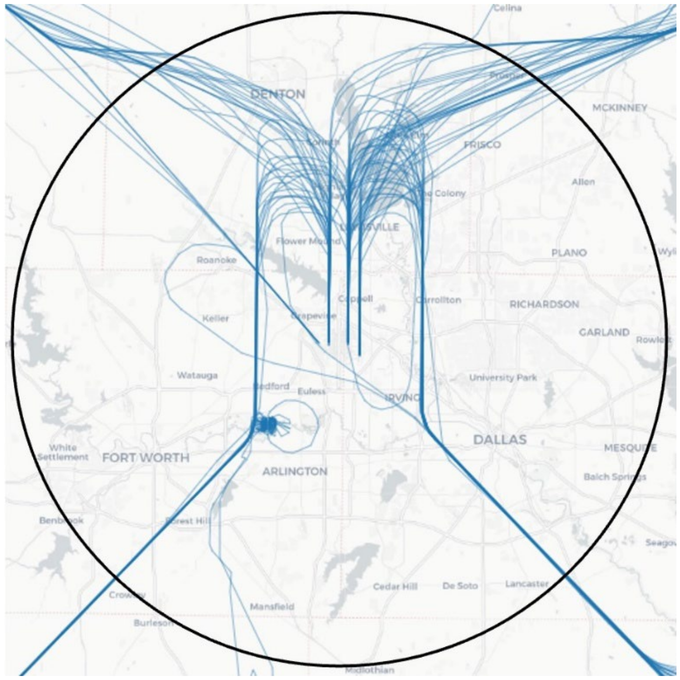


Figure 22 – Sample DFW Arrival Flight Paths with 25 NM Radius Ring

Most airports have established weather minima below which visual operations cannot be conducted. This limitation is in part due to the difficulty in visually acquiring traffic in such conditions. While weather is not an operational metric, it is an important factor in the analyses. The analyses categorize weather by ceiling and visibility at the airport (as opposed to on arrival or during approach) primarily because this data is available. The following weather category definitions were used:

- IMC uses basic minimums (less than 1000-foot ceiling or less than 3 miles visibility)
- MMC1 is based on a Visual Approach Threshold value listed in ASPM for DFW (less than 3500-foot ceiling or less than 5 miles visibility)
- MMC2 is based on information gathered from D10 facility personnel (less than 6000-foot ceiling or less than or equal to 8 miles visibility)

While IMC is a common definition in air traffic management, MMC1 and MMC2 were defined by the AIRS team to examine the impact of weather conditions on utilization of CAS-A operations. The MMC2 definition was based on input from D10 facility personnel and is believed to more accurately represent the point where visual operations are typically suspended. Figure 23 presents a diagram of the ceiling and visibility regimes used in the DFW analyses.

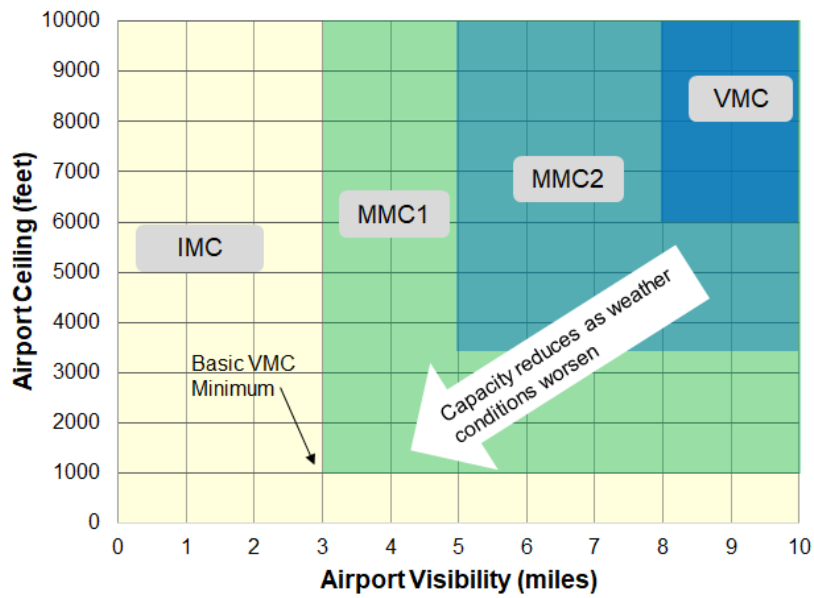


Figure 23 – Weather Regimes used in DFW Analyses

Multiple linear regression was used to control for various factors that affect flight time and distance in the terminal area. The only data removed from the analysis were flights during IMC. The dependent variables were gathered for all aircraft and the regressions included dependent demand variables to test the impact of different types of aircraft or operations landing in front of each flight. Different interaction terms were also examined (e.g., CAS-A operation involving a downwind flight segment or number of arrivals conducting a CAS-A operation in 15 minutes and MMC2) to test impacts that may only occur in certain situations. Correlation matrices were examined to make sure the independent variables were not correlated above a threshold (leading to misleading results). Different regression specifications were used for different analyses of the data. The results section lists the variables used in each analysis. Regression results included the coefficients of each independent variable, the significance of the coefficient (expressed as the P-value), and the overall goodness of fit of the model (adjusted R-squared).

Flight time and distance regressions were only used to analyze the impacts of CAS-A operations at DFW during the operational evaluation period (March 2023 through February 2025) since feedback from D10 controllers suggested that this was one way CAS-A operations were being used to improve the arrival flow to DFW.

4 Results

4.1 CAS-A Operational Evaluation Safety Hazard Assessment

During the SRM Panel for the CAS-A operational evaluation (as discussed in Section 2.11), one hazard was identified with four effects. This hazard and the effects were monitored and assessed throughout the operational evaluation through weekly virtual and monthly in-person meetings. Proposed CAS-A operations at D10 were reviewed with a team that included SMEs from FAA Headquarters, D10, NATCA, AAL, and ACSS. The team reviewed the identified safety concerns, as well as perceived safety benefits. During the operational evaluation, there was no data that indicated an incorrect TTF was designated and used for a CAS-A operation.

The results of monitoring the four effects identified by the SRM Panel are discussed below.

- **Effect 1: CAS-A aircraft and TTF are too close to apply runway separation**
  - The team reviewed all go-arounds/missed approaches where a CAS-A operation preceded the go-around/missed approach. Because the team concluded none of the go-arounds/missed approaches were caused by CAS-A operations, the likelihood of this effect was not increased from the panel's predictions. See Section 4.4.3 for more quantitative information about go-arounds.
- **Effect 2: Increased communication/Increased workload**
  - It was expected that there may be some flight crew confusion with the initiation of the CAS-A operation, but the frequency of occurrence in the operational evaluation exceeded the initial estimates of the SRM panel. Although the actual hazard of designating the wrong TTF was not realized (that would lead to an effect of increased communication and workload), there was increased communication overall due to CAS-A operations, and the likelihood of this effect was Frequent, versus the original rating of Remote. Regardless, the risk remained Low, and it could be assumed as CAS-A operations expanded to more airports and flight crews became more proficient with CAS-A operations, this effect would be reduced.
- **Effect 3: Loss of Situational Awareness on flight deck**
  - This effect was not recognized in any reports gathered by APA. There was reported confusion over call signs, or about which was the correct aircraft to designate; however, the flight crews appeared to have maintained situational awareness of the arrival and operation of their aircraft.
- **Effect 4: Loss of separation with another aircraft**
  - None of the CAS-A operations realized a loss of separation with another aircraft.

In addition, the FAA Air Traffic Safety Action Program (ATSAP) is a non-punitive Voluntary Safety Reporting Program for FAA ATC personnel. ATSAP enables air traffic controllers to voluntarily identify and report safety and operational concerns. The AIRS team looked for and formally requested any ATSAP reports associated with CAS-A operations at D10. None were found.

4.2 Flight Crew Utilization and Quantified Impact

4.2.1 Flight Crew Utilization Measured via Traffic Designation events

The ASA system allows flight crews to designate traffic any time during a flight and can be used multiple times per flight to gain additional traffic awareness. The methodology used to produce the results in this subsection was described in Section 3.11.1. Figure 24 shows the number of Traffic Designation events grouped by destination airport for the period of September 2020 to September 2024 (49 months). The highest number of Traffic Designation events during this period occurred for flights with DFW as the destination airport.

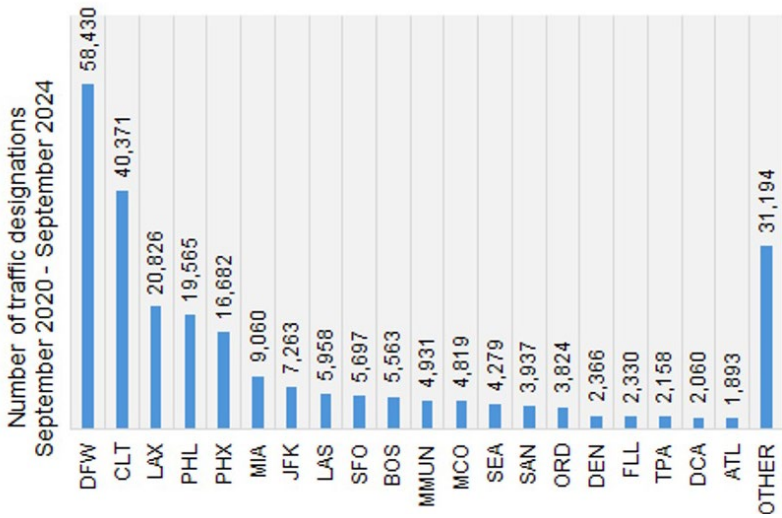


Figure 24 – Traffic Designation Events by Destination Airport, Sept 2020 - Sept 2024

Figure 25 presents the average duration in minutes of all Traffic Designation events on flights to the indicated destination airport. Figure 25 shows a representative sample of the 122 destination airports for which data was collected. Kahului International Airport (OGG) and Honolulu International Airport (HNL) are not plotted due to their effect on the vertical axis scaling. Each Traffic Designation event duration depended on how the flight crew were using the ASA system and in what context. On average, Traffic Designation events for DFW arrivals lasted almost 15 minutes. Traffic Designation event durations for LAX arrivals averaged around 27 minutes, possibly due to long arrival/approach routes from the East. Average Traffic Designation event durations at PHX exceeding 25 minutes may reflect the separate I-IM operational evaluation in Albuquerque Center (ZAB).[25] The longest average Traffic Designation event durations, 79 minutes for arrivals into OGG and 71 minutes for arrivals into HNL, occurred on flights involving oceanic routes where extended use of traffic awareness may be of particular use in saving fuel.[26] The duration of all Traffic Designation events by AAL flight crews during this four-year period was 75,598 hours.

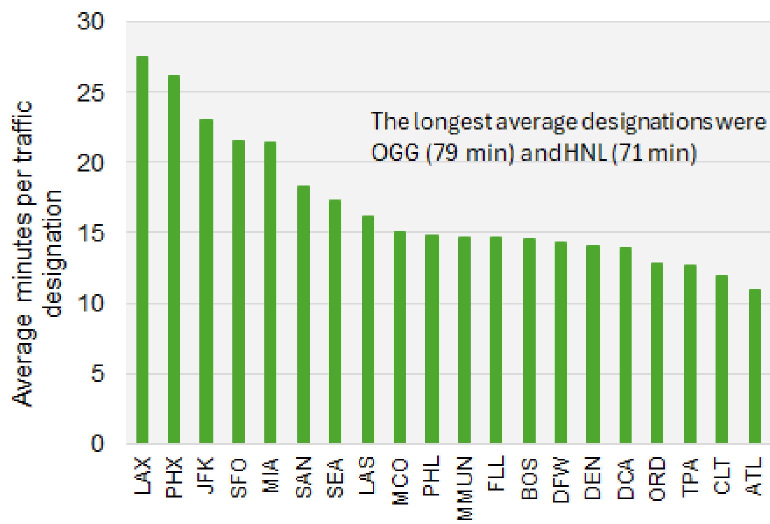


Figure 25 – Average Traffic Designation Event Duration by Destination Airport, Sept 2020 - Sept 2024

4.2.2 Flight Crew Utilization of CAVS and CAS-A Operations

AAL was approved to conduct CAVS operations in May 2021 and CAS-A operations at DFW commenced in March 2023. The methodology used to produce the results in this section was described in Section 3.11.2. Table 3 shows the monthly number of arrivals that designated traffic within a 25 NM radius of the indicated AAL hub airport during the period from January 2022 to December 2023 (24 months). Traffic Designation events within 25 NM of each airport generally increased over this two-year period.

Table 3 – Arrivals Designating Traffic within 25 NM of Airport, Jan 2022 - Dec 2023

Airport	1/22	2/22	3/22	4/22	5/22	6/22	7/22	8/22	9/22	10/22	11/22	12/22	CY22
CLT	55	68	116	160	280	267	279	262	139	165	402	552	2,745
DFW	90	149	237	385	603	587	537	482	244	231	488	765	4,798
LAX	24	42	47	55	123	128	109	135	81	78	113	201	1,136
MIA	7	24	34	24	47	52	69	45	29	27	55	85	498
PHL	27	40	70	92	133	158	202	178	78	92	141	276	1,487
PHX	21	31	55	36	70	95	74	70	42	51	120	153	818

Airport	1/23	2/23	3/23	4/23	5/23	6/23	7/23	8/23	9/23	10/23	11/23	12/23	CY23
CLT	495	574	762	749	932	1,101	1,033	1,125	1,081	1,312	1,222	904	11,290
DFW	659	829	1,354	1,146	1,453	1,546	1,226	1,498	1,542	1,744	1,471	1,254	15,722
LAX	153	195	291	284	353	373	381	387	431	387	321	279	3,835
MIA	85	94	153	127	120	163	153	140	166	153	151	145	1,650
PHL	247	214	307	362	399	447	470	422	442	497	397	390	4,594
PHX	184	231	238	277	220	202	195	204	255	292	321	242	2,861

CAS-A operations were used by controllers at D10 for DFW arrivals from March 2023 to February 2025. During this period, Table 4 shows the monthly number of DFW total arrivals, AAL A321 arrivals, AAL A321 arrivals designating traffic within 25 NM of DFW, and AAL A321 arrivals conducting a CAS-A operation. Note that the numbers for “AAL A321 arrivals designating traffic within 25 NM of DFW” are inclusive of all “arrivals with CAS-A operation.”

This table shows that over 25% of AAL A321 flight crews were designating traffic during their arrival to DFW during the period.

Table 4 – Operations at DFW (March 2023 - February 2025)

Month	Total Arrivals	AAL A321 Arrivals	AAL A321 Arrivals Designating Traffic within 25 NM of DFW	Arrivals with CAS-A Operation
3/2023	28,364	5,521	1,354	282
4/2023	27,549	5,326	1,146	100
5/2023	29,202	5,707	1,453	276
6/2023	30,502	5,871	1,546	227
7/2023	31,564	6,113	1,226	177
8/2023	31,827	6,086	1,498	332
9/2023	28,890	5,501	1,542	269
10/2023	30,215	5,847	1,744	116
11/2023	28,602	5,396	1,471	107
12/2023	29,040	5,546	1,252	70
1/2024	27,871	4,737	1,542	52
2/2024	27,333	5,113	1,558	107
3/2024	30,498	5,533	1,505	136
4/2024	29,325	5,168	1,126	110
5/2024	30,573	5,318	1,348	74
6/2024	32,653	5,952	1,541	107
7/2024	34,217	6,192	1,637	140
8/2024	33,195	5,719	1,478	85
9/2024	30.704	5,079	1,399	84
10/2024	33,058	5,778	1,621	52
11/2024	29,852	5,251	1,464	22
12/2024	31,214	5,564	1,583	32
1/2025	28,568	5,121	1,479	20
2/2025	27,164	4,861	662	34
TOTAL	**721,980**	**132,300**	**33,495**	**3,011**

Note that the number of Traffic Designation events for February 2025 was much lower than prior months. As discussed in Section 3.1, there was a time lag between when a Traffic Designation event occurred and when the SafeRoute+ data containing that event was provided to the FAA. The last SafeRoute+ data download was received by FAA on 18-Mar-2025. Based on experience from the prior months of the operational evaluation, all AAL aircraft SafeRoute+ data for February 2025 was not received by that date.

4.2.3 Inter-Arrival Time and Inter-Arrival Distance Results

Inter-Arrival Time (IAT) and Inter-Arrival Distance (IAD) were analyzed in multiple ways, as described in Section 3.11.3. The analyses were separated into two groups:

1. Impacts of designating traffic only for A321 arrivals across six AAL hubs over a two-year period (January 2022 - December 2023).
2. Impacts of designating traffic and CAS-A operations for AAL A321 arrivals at DFW during the operational evaluation period (March 2023 - February 2025).

4.2.3.1 Impact of Designating Traffic on IAT/IAD at six AAL Hubs

This section presents descriptive statistics for each of six AAL hub airports for three cases: Non-AAL A321 arrivals, AAL A321 arrivals not designating traffic within 25 NM of the airport (AAL Not Designating), and AAL A321 arrivals designating traffic within 25 NM of the airport (AAL Designating). Table 5 shows the IAT results for the six AAL hub airports and three cases, while Table 6 shows the corresponding IAD results. At all six AAL hub airports, the AAL Designating case exhibited lower average, median, and standard deviation values than the other two cases.

Table 5 – A321 IAT Results at AAL Hub Airports (January 2022 – December 2023)

Airport	A321 IAT Metrics	Non-AAL	AAL Not Designating	AAL Designating
DFW	Average IAT Seconds (seconds)	117	112	98
	Median IAT (seconds)	106	101	91
	Standard Deviation IAT (seconds)	37	36	27
	Observations	7,739	77,190	17,528
CLT	Average IAT (seconds)	115	110	94
	Median IAT (seconds)	107	100	87
	Standard Deviation IAT (seconds)	37	37	27
	Observations	1,542	61,992	11,991
LAX	Average IAT (seconds)	133	134	124
	Median IAT (seconds)	128	129	118
	Standard Deviation IAT (seconds)	35	36	31
	Observations	29,136	28,409	4,268
MIA	Average IAT (seconds)	128	129	112
	Median IAT (seconds)	119	121	105
	Standard Deviation IAT (seconds)	39	40	32
	Observations	6,535	12,703	1,506
PHL	Average IAT (seconds)	123	116	100
	Median IAT (seconds)	114	106	93
	Standard Deviation IAT (seconds)	37	37	28
	Observations	4,748	23,802	5,050
PHX	Average IAT (seconds)	120	120	105
	Median IAT (seconds)	110	111	97
	Standard Deviation IAT (seconds)	39	39	31
	Observations	8,063	28,482	3,068

Table 6 – A321 IAD Metrics at AAL Hub Airports (January 2022 – December 2023)

Airport	A321 IAD Metrics	Non-AAL	AAL Not Designating	AAL Designating
DFW	Average IAD (NM)	4.7	4.5	3.9
	Median IAD (NM)	4.1	4.0	3.6
	Standard Deviation IAD (NM)	1.6	1.6	1.2
	Observations	7,738	77,190	17,519
CLT	Average IAD (NM)	4.7	4.6	3.9
	Median IAD (NM)	4.2	4.1	3.5
	Standard Deviation IAD (NM)	1.7	1.7	1.2
	Observations	1,542	61,983	11,991
LAX	Average IAD (NM)	5.5	5.6	5.1
	Median Spacing (NM)	5.1	5.2	4.7
	Standard Deviation IAD (NM)	1.8	1.7	1.5
	Observations	29,132	28,404	4,267
MIA	Average IAD (NM)	5.2	5.3	4.5
	Median IAD (NM)	4.7	4.9	4.2
	Standard Deviation IAD (NM)	1.8	1.9	1.5
	Observations	6,535	12,703	1,506
PHL	Average IAD (NM)	4.7	4.5	3.9
	Median IAD (NM)	4.3	4.1	3.6
	Standard Deviation IAD (NM)	1.6	1.5	1.1
	Observations	4,748	23,800	5,050
PHX	Average IAD (NM)	5.1	5.0	4.3
	Median IAD (NM)	4.6	4.5	3.9
	Standard Deviation IAD (NM)	1.9	1.8	1.4
	Observations	8,060	28,478	3,068

Note that the numbers of observations for each airport and case may be slightly different for Table 5 versus Table 6. When this occurred, it was due to the data analysis method used. All trajectory data was interpolated to estimate the time when a given aircraft and its following aircraft were at the runway threshold. For the following aircraft, if there was not a surveillance position report[39] for that aircraft's trajectory within plus or minus 4 seconds of the time that the given (leading) aircraft crossed the runway threshold, the trajectory was declared as unreliable for measuring IAD and no IAD was recorded for that aircraft pair. This did not happen often because the trajectory data used was constructed from a combination of surveillance sources, including terminal cooperative surveillance radar (nominal 5-second update rate), ADS-B (nominal 1-second update rate), and an FAA airport surface surveillance system (nominal 1-second update rate).

Figure 26 presents a visualization of the IAT and IAD distributions at DFW.

[39] A surveillance position report could be either measured data from a cooperative surveillance sensor or received data from a valid ADS-B report.

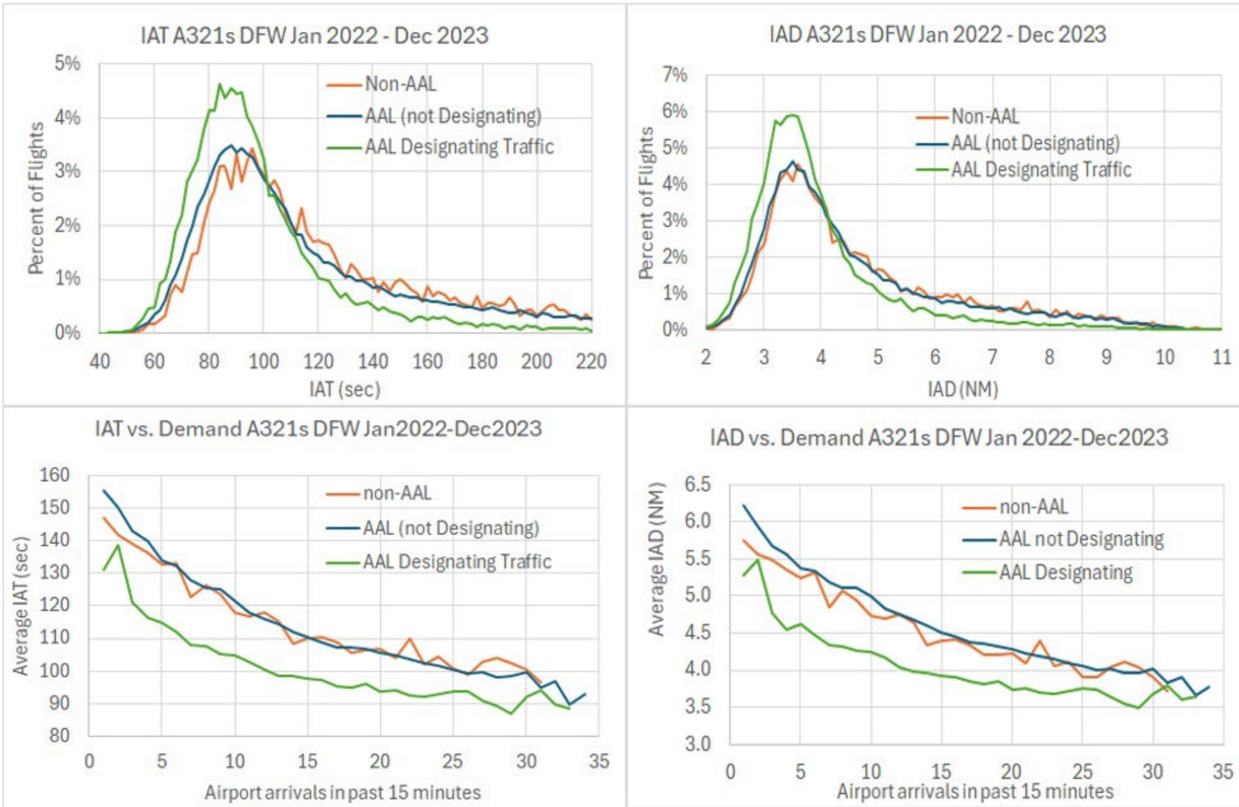


Figure 26 – Distributions and Demand Trends at DFW

For both IAT and IAD, the AAL Designating distribution (top of Figure 26) had a higher peak and that peak was skewed to the left, which was aligned with the statistical measures. The minimum for all distribution curves was approximately the same, indicating that flight crew designation of traffic did not change the minimum IAT/IAD.

One possible reason for the difference in average and variation results between the cases was that they represented different levels of arrival demand at the airport. One might expect times of higher demand to naturally exhibit lower IAT/IAD average values with less variation. To test this hypothesis, the average IAT and IAD were plotted versus arrival demand (bottom of Figure 26). Arrival demand was approximated by measuring the number of arrival aircraft that landed during the past 15 minutes at the airport for each flight. The number of arrivals at the airport was used instead of the number of arrivals at the individual runway because DFW (and many of the other hub airports) have multiple arrival runways over which demand is distributed by ATC.

The bottom of Figure 26 shows a steady decrease in both average IAT and IAD values as demand increases. However, the average IAT and IAD was less for the AAL Designating case compared to the other cases for every level of demand. This indicated that the reduction seen in the distributions represented different behavior by the flight crews.

Figure 27 displays IAT distribution and average IAT versus arrival demand for the other five AAL hub airports and Figure 28 repeats this information for IAD. Note that CLT does not have a non-AAL curve because there were not enough non-AAL A321 operations at CLT during the period to create reasonable distributions.

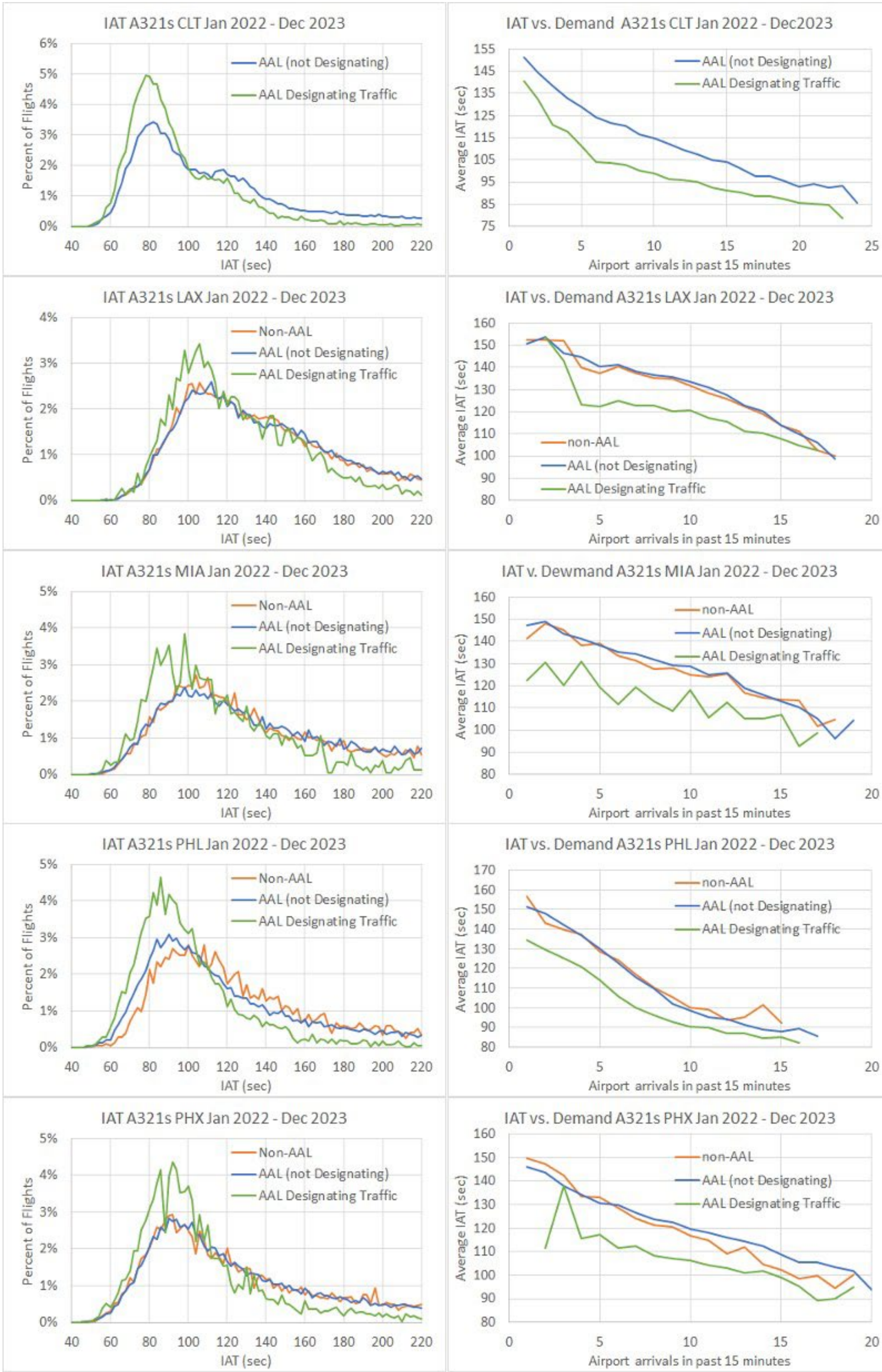


Figure 27 – IAT Distributions and Demand Trends at CLT, LAX, MIA, PHL, and PHX

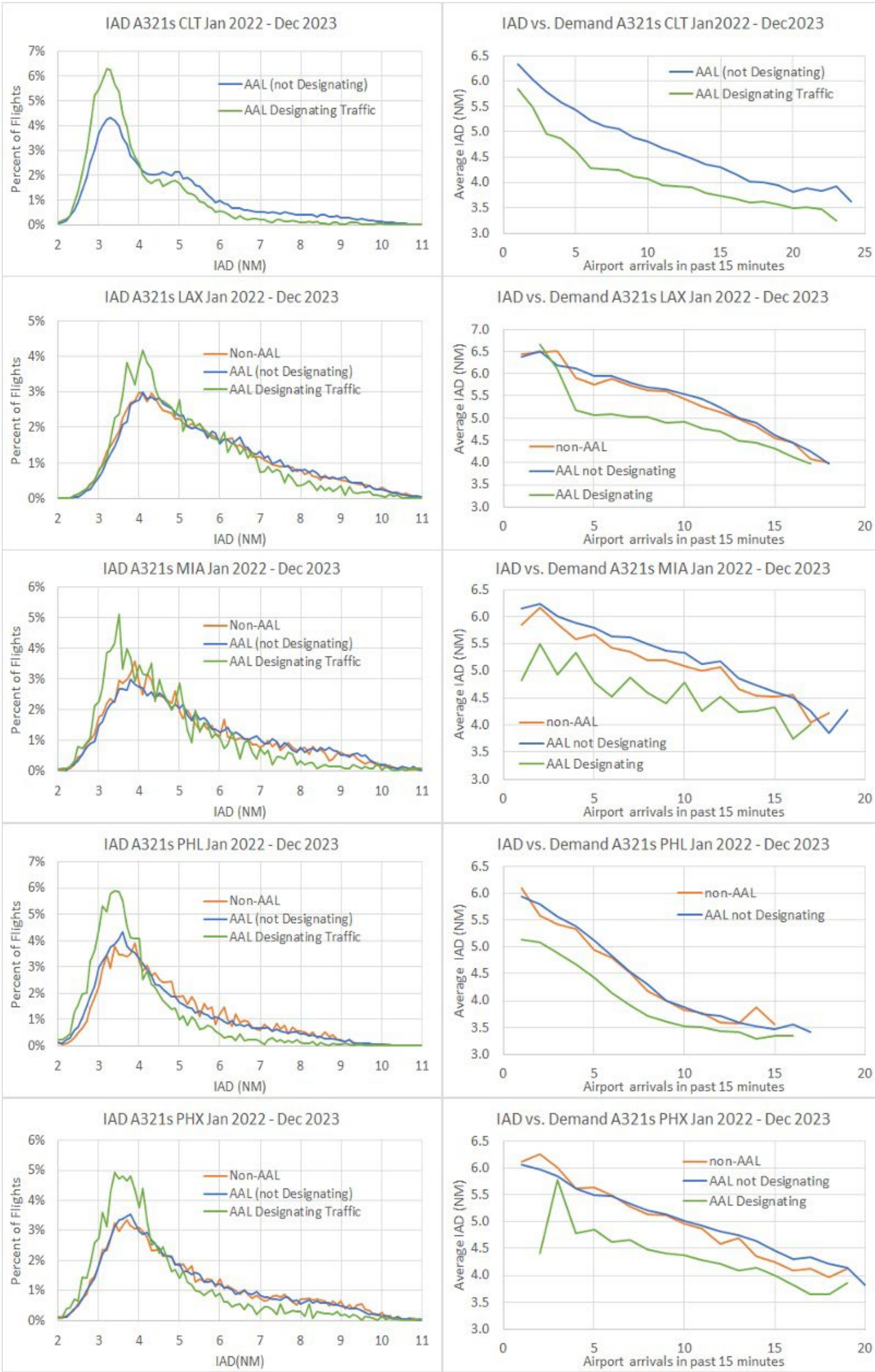


Figure 28 – IAD Distributions and Demand Trends at CLT, LAX, MIA, PHL, and PHX

4.2.3.2 IAT/IAD Regression Analyses for Traffic Designation events at six AAL Hubs

Regression analyses were performed to understand the impacts of both airport arrival demand and Traffic Designation events simultaneously, using the following specifications:

Dependent Variables:

- IAT, measured at each arrival runway
- IAD, measured at each arrival runway

Independent Variables:

- Arrivals in the past 15 minutes at the airport
- Behind a heavy (0 = No, 1 = Yes) going to the same arrival runway
- AAL (0 = No, 1 = Yes)
- AAL Designating Traffic within 25 NM of airport (0 = No, 1 = Yes)

Table 7 presents the results of the regression analysis.

Table 7 – IAT and IAD Regression Analysis Results at AAL Hub Airports

Airport	Predictors	IAT Coefficient (seconds)	P-Value	IAD Coefficient (NM)	P-Value
DFW	Baseline IAT/IAD (per runway)	135	<< 0.05	5.41	<< 0.05
	Arrivals in past 15 min (airport)	-1.4	<< 0.05	-0.06	<< 0.05
	Behind a Heavy	41.8	<< 0.05	1.80	<< 0.05
	AAL	**N/A**	0.08[40]	0.08	<< 0.05
	AAL Designating Traffic	-12.7	<< 0.05	-0.57	<< 0.05
CLT	Baseline IAT/IAD (per runway)	143	<< 0.05	5.89	<< 0.05
	Arrivals in past 15 min (airport)	-2.3	<< 0.05	-0.10	<< 0.05
	Behind a Heavy	40.3	<< 0.05	1.86	<< 0.05
	AAL	-4.3	<< 0.05	**N/A**	0.5
	AAL Designating Traffic	-12.3	<< 0.05	-0.56	<< 0.05
LAX	Baseline IAT/IAD (per runway)	156	<< 0.05	6.63	<< 0.05
	Arrivals in past 15 min (airport)	-2.5	<< 0.05	-0.13	<< 0.05
	Behind a Heavy	26.9	<< 0.05	1.19	<< 0.05
	AAL	1.1	<< 0.05	0.09	<< 0.05
	AAL Designating Traffic	-10.7	<< 0.05	-0.53	<< 0.05
MIA	Baseline IAT/IAD (per runway)	148	<< 0.05	6.09	<< 0.05
	Arrivals in past 15 min (airport)	-2.2	<< 0.05	-0.10	<< 0.05
	Behind a Heavy	27.3	<< 0.05	1.18	<< 0.05
	AAL	1.6	<< 0.05	0.18	<<0.05
	AAL Designating Traffic	-14.7	<< 0.05	-0.70	<< 0.05
PHL	Baseline IAT/IAD (per runway)	154	<< 0.05	5.94	<< 0.05
	Arrivals in past 15 min (airport)	-5.0	<< 0.05	-0.19	<< 0.05
	Behind a Heavy	29.0	<< 0.05	1.21	<< 0.05
	AAL	**N/A**	0.12	0.06	<< 0.05
	AAL Designating Traffic	-11.1	<< 0.05	-0.46	<< 0.05
PHX	Baseline IAT (per runway)	141	<< 0.05	6.05	<< 0.05
	Arrivals in past 15 min (airport)	-2.3	<< 0.05	-0.11	<< 0.05
	Behind a Heavy	26.7	<< 0.05	1.14	<< 0.05
	AAL	2.7	<< 0.05	0.05	0.01
	AAL Designating Traffic	-13.5	<< 0.05	-0.63	<< 0.05

[40] A p-value greater than 0.05 indicated there was no statistically significant effect for that independent variable. In such cases, the p-value was listed but the coefficient was marked as Not Applicable (N/A).

Note that although IAT and IAD were computed per arrival runway, the results are essentially aggregated across all arrival runways at a given airport to obtain an average IAT/IAD per runway. Arrival demand was captured at the airport level since at most of the AAL hub airports (and DFW in particular), simultaneous arrivals to parallel arrival runways are regularly in use and arrival demand is managed at the airport level (not at the runway level). Recall also that IAT/IAD computations were filtered, as described in Section 3.11.3, to remove gaps in the arrival flow (IAT > 220 seconds) and arrivals when there were IMC conditions at an airport.

The regression results from Table 7 show the following:

- The coefficient of AAL Designating traffic indicated IAT reductions ranging from 11 to 13 seconds and IAD reductions ranging from 0.5 to 0.6 NM, which agreed with the previous examination of the statistical average values.
- The IAT/IAD coefficients of AAL were small and sometimes statistically insignificant, so the impacts on IAT/IAD seen in the regression analysis were not related to AAL arrivals, but mostly to AAL arrivals where the flight crews designated traffic.

The resulting per runway IAT or IAD was a linear combination of the independent variables multiplied by the relevant coefficients added to the per runway baseline IAT or IAD. Using IAT as an example, this could be written as a formula:

IAT = Baseline IAT + IAT $\text{Coefficient}_{\text{Arr-n-past-15min}}$ * Number of airport arrivals in past 15 min +
IAT $\text{Coefficient}_{\text{BehindHeavy}}$ * (1 if behind a heavy and 0 if not) +
IAT $\text{Coefficient}_{\text{AAL}}$ * (1 if AAL aircraft and 0 if not) +
IAT $\text{Coefficient}_{\text{AALDesignating}}$ * (1 if AAL Designating Traffic and 0 if not)

Note: *IAT Coefficients that were not statistically significant were not used (e.g., "AAL" for DFW).*

For example, at DFW if we assumed a given aircraft had 20 other aircraft arriving at the airport ahead of them in the past 15 minutes, the given aircraft was not behind a heavy, and the given aircraft's flight crew had designated traffic, we obtain the following values:

IAT = 135 + (-1.4) * 20 + 26.7 * 0 + (-12.7) * 1 = 94 seconds

If all 20 aircraft flight crews arriving at DFW ahead of a given aircraft in a 15-minute window[41] were designating traffic and received the 13-second IAT reduction, the runway throughput could be increased by up to five aircraft per hour for each arrival runway. The benefit was derived in the following manner.

- IAT = 135 seconds – 20 aircraft * 1.4 seconds = 107 seconds per aircraft per runway
- The arrival throughput would be (60 * 60 seconds/hour) / (107 seconds/aircraft) = 33 aircraft per arrival runway per hour.
- Each aircraft flight crew designating traffic would reduce IAT by an additional 13 seconds per aircraft per runway, so (60 * 60 seconds/hour) / (107 - 13 seconds/aircraft) = 38 aircraft per arrival runway per hour.

[41] Note that having 21 consecutive arrivals to DFW with flight crews designating traffic would require very high equipage fractions and a higher percentage of flight crews designating traffic than was observed during data collection. However, this example is offered to illustrate the potential opportunity based on the data collected.

4.2.3.3 Designating Traffic for DFW Arrivals and CAS-A Operations

As described in Section 3.11.3, separate analyses of IAT and IAD were performed at DFW to include CAS-A operations. These analyses were very similar to the analyses performed across all six AAL hubs; however, the date range was March 2023 through February 2025 (to capture full impacts of CAS-A operations which occurred during this period) and the sets of aircraft were limited to AAL A321 aircraft (IAT/IAD for non-AAL A321 aircraft were not analyzed).

Table 8 presents descriptive statistics for IAT and IAD for flights when flight crews were Not Designating traffic, Designating traffic, and conducting a CAS-A operation. Note that the data from CAS-A operations is included in the data classified as Designating traffic. Figure 29 presents the distribution and demand trends for the cases and Table 9 presents the regression analysis results.

The dotted lines in Figure 29 represent the subset of flights Designating traffic that were CAS-A operations. The IAT/IAD characteristics of flights conducting CAS-A operations were very similar to all flights that were Designating traffic.

Table 8 – IAT and IAD Metrics for AAL 321s at DFW, March 2023 – February 2025

Airport	AAL A321 Metrics	Not Designating Traffic	Designating Traffic	CAS-A Op
DFW	Average IAT (seconds)	112	97	97
	Median IAT (seconds)	101	91	93
	Standard Deviation IAT (seconds)	37	26	25
	Observations	69,870	29,532	2,618
	Average IAD (NM)	4.6	3.9	3.9
	Median IAD (NM)	4.0	3.6	3.7
	Standard Deviation IAD (NM)	1.7	1.1	1.1
	Observations	69,870	29,532	2,618

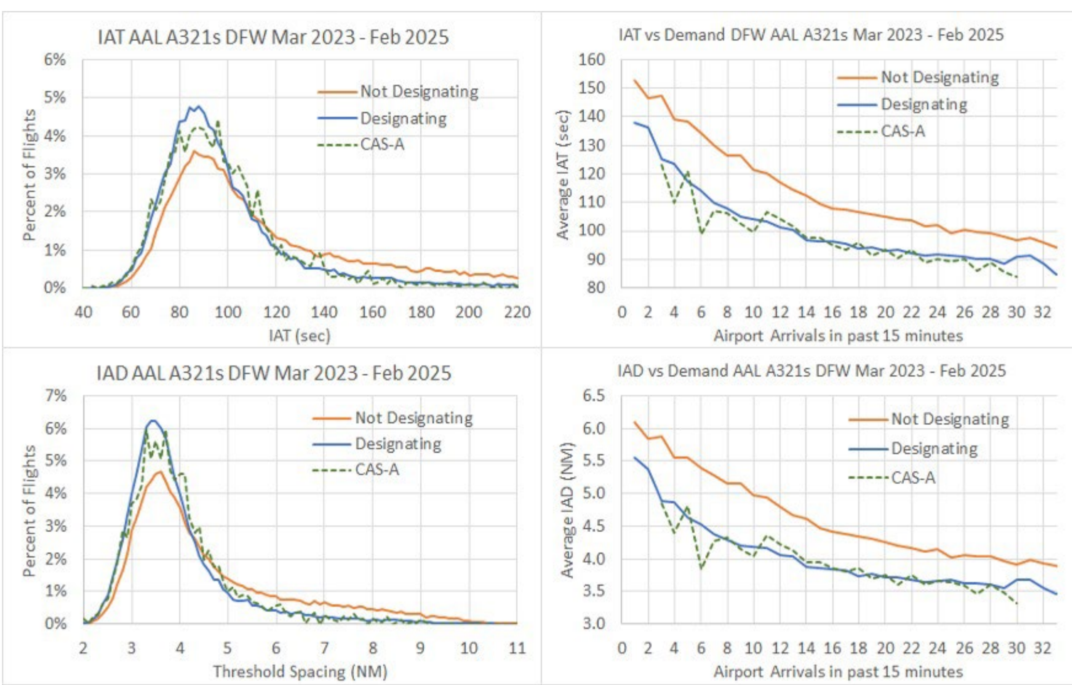


Figure 29 - Distribution and Demand Trends at DFW, March 2023 – February 2025

Table 9 – IAT/IAD Regression Analysis Results for CAS-A Operations

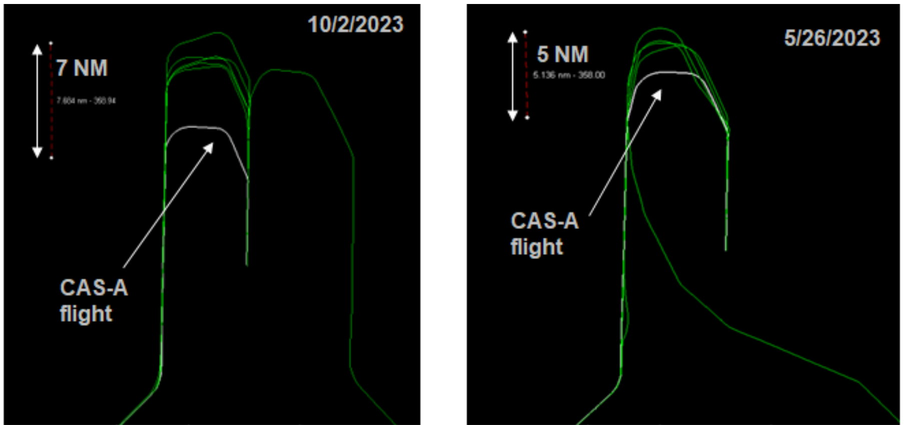
Airport	Predictors	IAT Coefficient (seconds)	P-Value	IAD Coefficient (NM)	P-Value
DFW	Baseline IAT	134.9	<< 0.05	5.5	<< 0.05
	Arrivals in past 15 min airport	-1.4	<< 0.05	-0.1	<< 0.05
	Behind a Heavy	41.1	<< 0.05	1.8	<< 0.05
	Designating Traffic	-12.9	<< 0.05	-0.6	<< 0.05
	CAS-A Operation	-2.1	<< 0.05	**N/A**	0.23[42]

The IAT/IAD statistical measures, trends and regression results for CAS-A operations were similar to the analyses in Section 4.2.3.1 and Section 4.2.3.2. Arrivals where flight crews conducted a CAS-A operation still showed a 13 second decrease in IAT and a 0.6 NM reduction in IAD. In the regression analysis, arrivals involving a CAS-A operation experienced an additional 2 second decrease in IAT but no significant change in IAD.

4.2.4 Impact of CAS-A Operations on Flight Time/Distance for DFW Arrivals

While reducing IAT and IAD for arrivals designating traffic was beneficial, it was also considered important to examine the impact on time and distance flown during CAS-A operations. Controllers reported that with CAS-A operations the flight distance would be reduced during certain conditions. In one scenario, D10 controllers' increased confidence in the ability of a flight crew conducting a CAS-A operation to acquire and keep track of the TTF allowed D10 controllers to reduce the downwind flight distance significantly by moving aircraft conducting CAS-A operations into what would have previously been unused or partially unused arrival gaps. Figure 30 shows a few examples where flights conducting a CAS-A operation flew a considerably shorter downwind and final approach (measured within 25 NM of the airport) compared to other traffic during the same period. Figure 30 includes noticeable examples, although the statistical analysis indicates the average impact was lower than shown. Controllers also indicated that they were more likely to shortcut a flight path in reduced weather conditions during a CAS-A operation. Some controllers reported being able to reduce the final approach segment length significantly. When a CAS-A operation resulted in a shorter flight path, it also impacted the flights behind it, allowing those flights to also reduce their flight distance/time. However, this benefit is limited if additional aircraft are not available to fill the unused arrival gaps created in the traffic flow when CAS-A operations are used. To take advantage of the unused arrival gaps, aircraft would have to be scheduled to the airport based on the anticipated use of CAS-A operations[27].

[42] A p-value greater than 0.05 indicated there was no statistically significant effect for that independent variable. In such cases, the p-value was listed but the coefficient was marked as Not Applicable (N/A).



ACID	Type	Landing	Flight distance (NM)
AAL1288	B738	19:32	57.5
AAL390	B738	19:33	54.8
SKW3285	CRJ7	19:35	53.1
AAL1304	A321	19:37	54.1
AAL1174	B738	19:39	53.6
AAL384	A321	19:41	45.2
AAL1068	A321	19:43	53.2

ACID	Type	Landing	Flight distance (NM)
AAL1967	A321	20:33	50.5
ENY3486	E170	20:42	57.1
AAL1372	A321	20:43	47.8
AAL1225	A321	20:46	52.1
AAL1097	A319	20:48	51.0

Figure 30 – Notable Examples of "Shortcut" Vectors from Downwind

To examine possible terminal area flight path and time changes, a regression analysis was conducted using two years of operations at DFW. The data included aircraft trajectories from IOAA, determination that a CAS-A operation occurred from CountOps, and airport weather conditions from ASPM. Flights during IMC were removed from the data because CAS-A operations were not allowed during those conditions. The regression used the following specifications:

Dependent Variables:

- Flight Time from crossing airport's 25 NM radius to runway
- Flight Distance from crossing airport's 25 NM radius to runway

Independent Variables:

- Downwind (0 = No, 1 = Yes)
- Go-around (0 = No, 1 = Yes)
- MMC2[43] (ceiling less than 6000 feet and visibility less than or equal to 8 miles)
- MMC1 (ceiling less than 3500 feet and visibility less than 5 miles)
- CAS-A ownship flew a downwind arrival segment
- CAS-A ownship flew a non-downwind arrival segment
- Arrivals at airport in past 15 minutes
- Heavy aircraft arrivals at airport in past 15 minutes (number of Heavy category aircraft in all non-IMC conditions)
- CAS-A operations at airport in past 15 minutes
- CAS-A operations at airport in past 15 minutes during MMC2
- CAS-A operations at airport in past 15 minutes during MMC1

Table 10 presents the regression analysis results for both flight distance and flight time.

[43] See Section 3.11.4 for further information on how MMC2 and MMC1 were defined.

Table 10 – Flight Time and Distance Regression Results for CAS-A Operations at DFW

Factors that impact Flight Distance and Time	Flight Distance Impact		Flight Time Impact	
	Coefficient (NM)	P-value	Coefficient (seconds)	P-value
Minimum distance	23.5	<< 0.05	436	<< 0.05
Downwind	26.7	<< 0.05	352	<< 0.05
Go-around	45.2	<< 0.05	811	<< 0.05
MMC2	2.2	<< 0.05	47	<< 0.05
MMC1	4.1	<< 0.05	94	<< 0.05
CAS-A ownship flew downwind on arrival	-0.9	<< 0.05	-24	<< 0.05
CAS-A ownship did not fly downwind on arrival	**N/A**	0.08[44]	**N/A**	0.82
Arrivals in past 15 min airport	0.2	<< 0.05	4	<< 0.05
Heavy aircraft arrivals in past 15 min	0.1	<< 0.05	3	<< 0.05
CAS-A operations in past 15 min	-0.2	<< 0.05	-8	<< 0.05
CAS-A operations in past 15 min during MMC2	-0.5	0.02	-9	0.01
CAS-A operations in past 15 min during MMC1	**N/A**	0.12	**N/A**	0.20
Observations	685,177		685,177	
Adjusted R-square	86%		77%	

The results of the regression analysis indicated the following:

- For each CAS-A operation involving an arrival with a downwind segment there was a reduction in flight distance of 0.9 NM or flight time of 24 seconds.
- For each airport arrival during non-IMC weather conditions (i.e. VMC, MMC1 and MMC2) there was a reduction in flight distance of 0.2 NM or flight time of 8 seconds for every CAS-A operation ahead during the past 15 minutes.
- For each airport arrival during MMC2 conditions there was an additional reduction in flight distance of 0.5 NM or flight time of 9 seconds for every CAS-A operation ahead during the past 15 minutes, for a total reduction of 0.7 NM or 17 seconds.

This analysis was repeated using arrivals where flight crews designated traffic without conducting a CAS-A operation – the analysis was unable to identify any statistically significant results for arrivals where flight crews designated traffic on their own. This result indicated that the mechanism for terminal area flight time/distance reduction was only available if controllers had knowledge of which aircraft were capable and a CAS-A operation occurred.

4.2.5 Monetizing Flight Time/Distance Reductions due to CAS-A Operations

The results of Section 4.2.4 were monetized using the measured data and some simple assumptions. Table 11 summarizes the regression results and shows the benefits to the CAS-A aircraft (ownship) as well as the benefit to other arriving aircraft if there was one CAS-A operation in the 15 minutes prior. The benefits for other arrival aircraft increased by the same value shown in the table if more CAS-A operations were in the same prior 15-minute window. As an example, if there were two CAS-A operations in front of a given aircraft during MMC2 weather conditions, that given aircraft would experience a reduction in distance of 1.4 NM.

[44] A p-value greater than 0.05 indicated there was no statistically significant effect for that independent variable. In such cases, the p-value was listed but the coefficient was marked as Not Applicable (N/A).

Table 11 – Flight Distance and Time Benefits Summary from Regression

CAS-A (Ownship) Arrival Benefit	Downwind	
Distance (NM)	0.9	
Time (seconds)	24	
Benefit for Each Arrival per Preceding CAS-A Operation in the Prior 15 Minutes	**MMC2**	**Other Non-IMC Weather**
Distance (NM)	0.7	0.2
Time (seconds)	17	8

Between March 2023 and February 2025, there were 1,618 CAS-A operations with a downwind arrival segment; this value can be multiplied by the top part of Table 11 to calculate a benefit. Table 12 presents the number of DFW arrivals that had specific numbers of CAS-A operations in the past 15 minutes for different weather conditions during the same period. The bottom part of Table 11 can be combined with the information in Table 12 to calculate a benefit for arrivals where different numbers of CAS-A operations occurred in the prior 15 minutes. For example, there were 131 arrivals that had three CAS-A operations occur in the prior 15 minutes during MMC2, so the flight time benefit for these flights would be 131*3*17 = 6,681 seconds or 111 minutes.

Table 12 – Frequency of CAS-A Operations in the Prior 15 minutes

Frequency of CAS-A Operations in Prior 15 Minutes	Arrivals in MMC2	Arrivals in all Non-IMC Weather
0	37,079	652,176
1	1,039	23,380
2	318	6,669
3	131	2,149
4	31	631
5	1	133
6		32
7		7

Combining the data from Table 11 and Table 12, aircraft conducting CAS-A operations and all other aircraft arriving at DFW within 15 minutes after a CAS-A operation resulted in total operational evaluation savings of 11,869 NM in flight distance or 7,188 minutes of flight time. Assuming an airline cost of approximately $60 per minute, the total savings would be $431,275. Transforming the measured time benefit into fuel and emissions benefits would result in a savings of almost 659,000 pounds of fuel and 944 metric tons of carbon dioxide. Considering that CAS-A operations during the operational evaluation constituted only about 2.28% of the total AAL A321 arrivals, a larger benefit was possible from this mechanism. For example, if we assumed all equipped AAL A321 arrivals into DFW had conducted a CAS-A operation, the yearly benefit would have been closer to 158,000 minutes of flight time savings having a value of about $9.5 million, as well as a savings of over 14 million pounds of fuel and about 21,000 metric tons of carbon dioxide.

4.3 Number of CAS-A Operations

Figure 31 shows the number of CAS-A operations per week from CountOps, based on VC/IC entries, and the total number of CAS-A operations, which was 3,011. This information was tracked every week within the AIRS team. Figure 32 shows the number of CAS-A operations per month from the same data source, for easier comparison with the results in the remainder of this section.

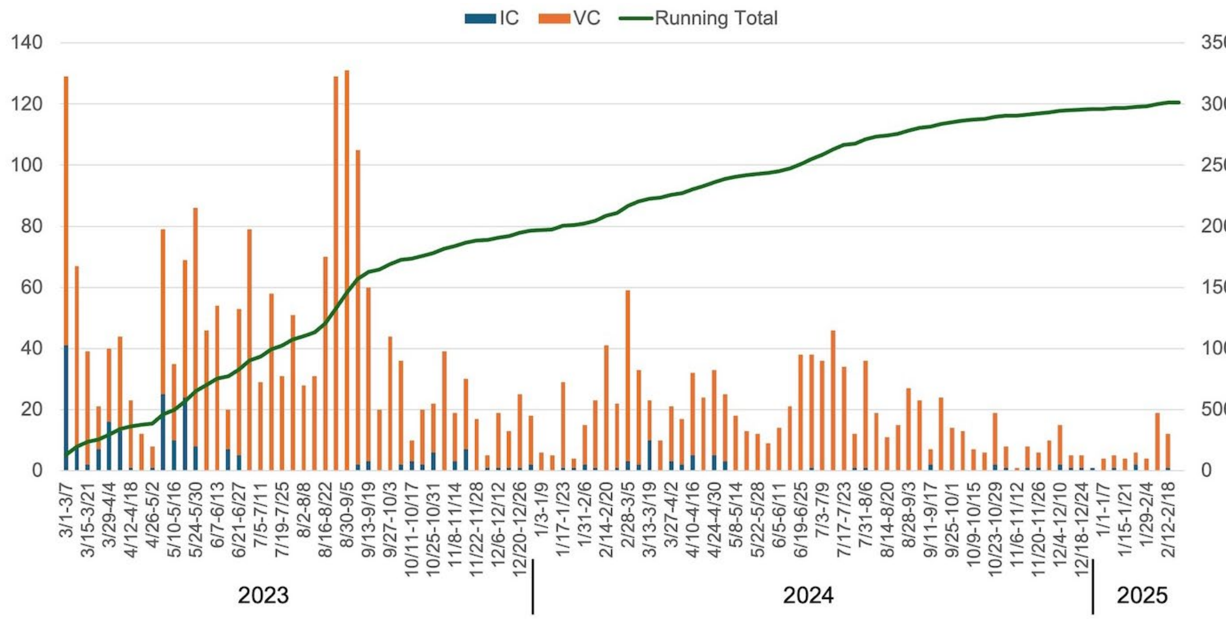


Figure 31 – Number of CAS-A Operations per Week and Running Total

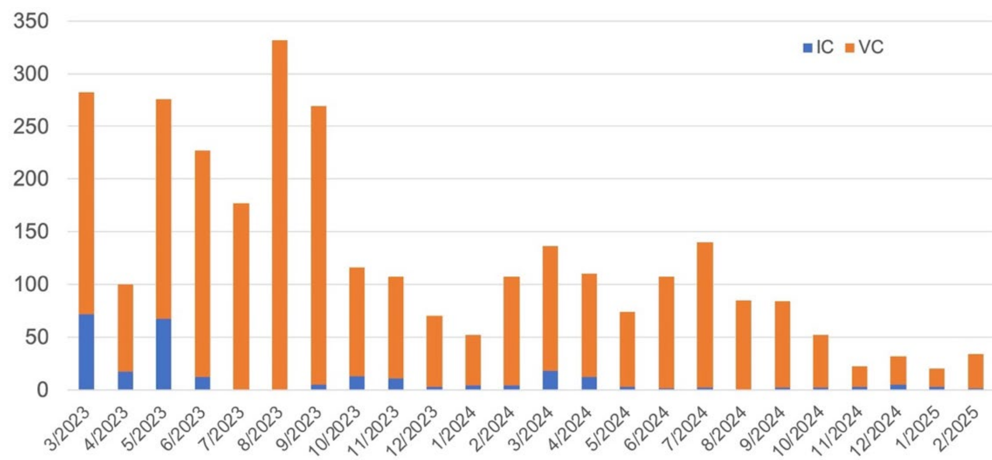


Figure 32 – Number of CAS-A Operations each Month

Note that the number of CAS-A operations was relatively high during the first week of the operational evaluation, then peaked again in late August and early September 2023, but never reached those levels again. Over half of the 3,011 CAS-A operations had occurred by September 12, 2023. Also note that the number of CAS-A operations associated with instrument approaches ("IC") were proportionally higher during the first three months of the operational evaluation than most subsequent periods.

There were several factors which could explain why the number of CAS-A operations declined notably after September 2023. First, this operational evaluation was constrained by the reality that ATC automation did not directly support the operation – specifically, controllers had to remember who was eligible for CAS-A operations; there was no automation prompting controllers. Second, there were multiple changes to DFW arrival operations that occurred during the operational evaluation, including a closed arrival runway and new procedures introduced to ensure safety during turns to final. Third, there were many controller trainees during late 2023 and into 2024 who were not authorized to initiate CAS-A operations. Fourth, in the fall of 2024, there was a major disruption to controller schedules which became a focus of attention for the workforce. Finally, despite the efforts of the AIRS team, there were only about 5-10 controllers at D10 who really embraced CAS-A operations and saw the benefits. By the last six months of the operational evaluation, there would only be CAS-A operations when one of those controllers were working the final controller position. See Section 4.6.2 for D10 controller perspectives.

4.4 Entries in the CAS-A Observations/Feedback Database

Of the 3,011 CAS-A operations, a sub-set was examined and logged in the CAS-A observations/feedback database (as discussed in Section 3.4). Additionally, attempted CAS-A operations which did not result in a VC/IC entry were also captured in the CAS-A observations/feedback database (see Section 3.1); therefore, there are attempted CAS-A operations in the database for which there was no corresponding CountOps data (since there was no CAS-A operation). The following sections review the details of all the observations made regarding both attempted and successful CAS-A operations.

4.4.1 Number of Attempted CAS-A Operations and Sources

There were 938 attempted CAS-A operations logged in the CAS-A observations/feedback database. That was 31% (938/3011) of the CAS-A operations that occurred during the operational evaluation. Figure 33 shows the total number of attempted CAS-A operations logged per month in the CAS-A observations/feedback database.

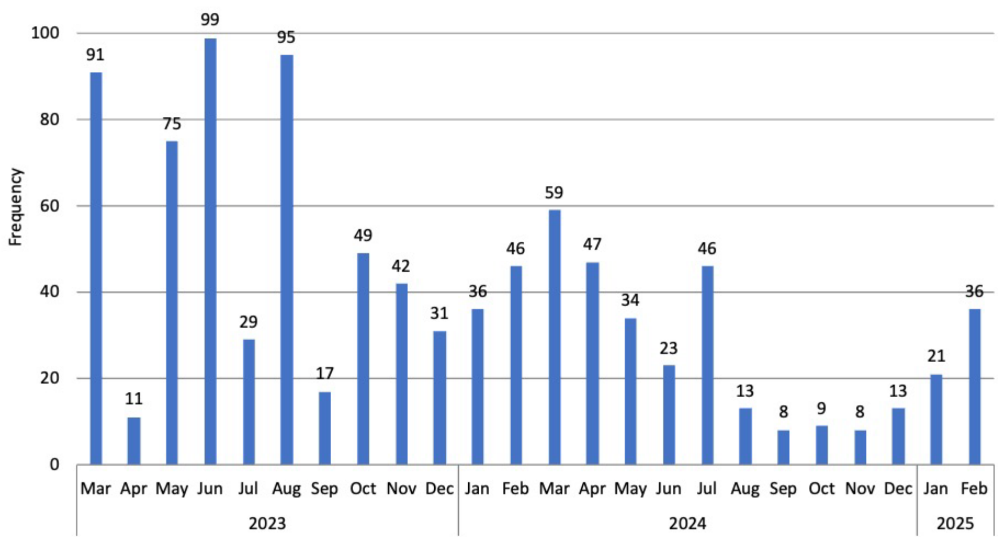


Figure 33 – Attempted CAS-A Operations Logged per Month

While there were 938 attempted CAS-A operations logged, a given attempted CAS-A operation could include data from only one source (e.g., an AIRS team SME observation) or a set of sources (e.g., an AIRS team SME observation and flight crew feedback), as noted in Section 3.1.

Figure 34 shows the sources and their percentages of the overall database. As shown, the majority (83%) of the data was from AIRS team SME observations.

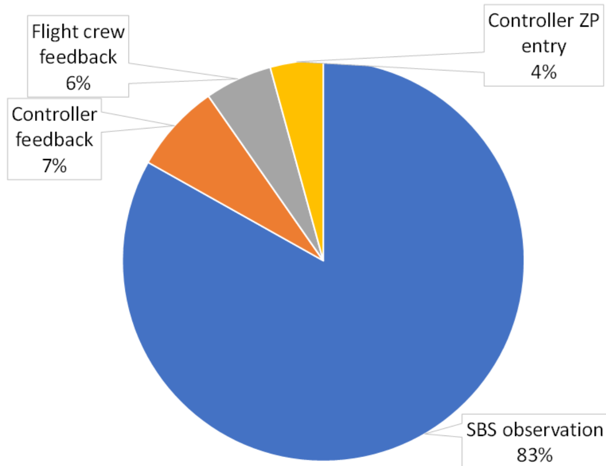


Figure 34 – Data Sources for Attempted CAS-A Operations

4.4.2 Initiating a CAS-A Operation

4.4.2.1 Traffic Designation Instruction

Initiating a CAS-A operation started with a controller instruction to designate a TTF. When a controller issued the traffic designation instruction, the observation SME logged the location of the aircraft receiving this instruction as being in one of the following zones based on the standard rectangular traffic pattern at an airport:[45]

- Downwind leg
- Base leg
- Final Approach

The following additional zones were also defined and used:

- Dogleg/intercept to final
- Beyond the traffic pattern

Figure 35 shows an example configuration of these zones for DFW runway 18R overlaid on a representative arrival traffic flow. Note that for runway 18R arrivals, typical downwind traffic was on the west side of DFW; however, there could be "crossover" traffic from the downwind on the east side, so those zones are shown (though were infrequently used).

[45] As defined in the FAA Aeronautical Information Manual, Section 4-3-2; see https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap4_section_3.html.

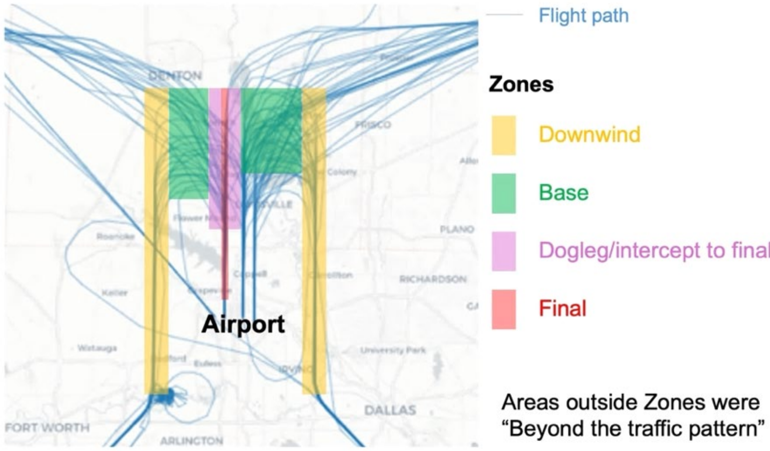


Figure 35 – Example Zones used to Identify where Traffic Designation Instruction Issued

As shown in Figure 36, usually the aircraft receiving a traffic designation instruction was beyond the traffic pattern (42%) or on downwind (44%) when a controller issued the instruction.

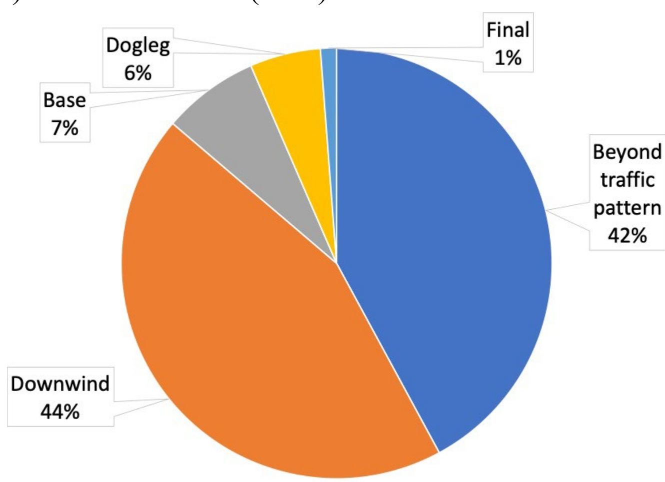


Figure 36 – Location of Aircraft when Traffic Designation Instruction Received

A traffic designation instruction could be issued in one of three situations, by:

1. One controller managing the Final Controller's airspace; or
2. One controller managing a combined Feeder and Final Controller's airspace; or
3. A Feeder Controller managing airspace adjacent to the Final Controller's airspace.

Of the 938 attempted CAS-A operations logged, 825 (88%) had information on which situation occurred. For 90.7% of the 825 attempted CAS-A operations, the controller that issued the traffic designation instruction was either managing a Final controller's airspace or combined Feeder/Final airspace (situations 1 and 2). For 9.3% of the 825 attempted CAS-A operations, a Feeder controller issued the traffic designation instruction (situation 3). No unique problems were noted in situation 3.

The initiation of a CAS-A operation could start in another way. Prior to a controller issuing the traffic designation instruction, the flight crew could have asked the controller who they were following or could offer to conduct a CAS-A operation. For this operational evaluation, these were called "pilot-prompted" operations. Pilot prompts were recorded starting in August 2023 and are shown by the month observed in Figure 37. During the operational evaluation, 42 pilot-prompts were observed (7% of the entries logged in the CAS-A observations/feedback database between August 2023 and February 2025).

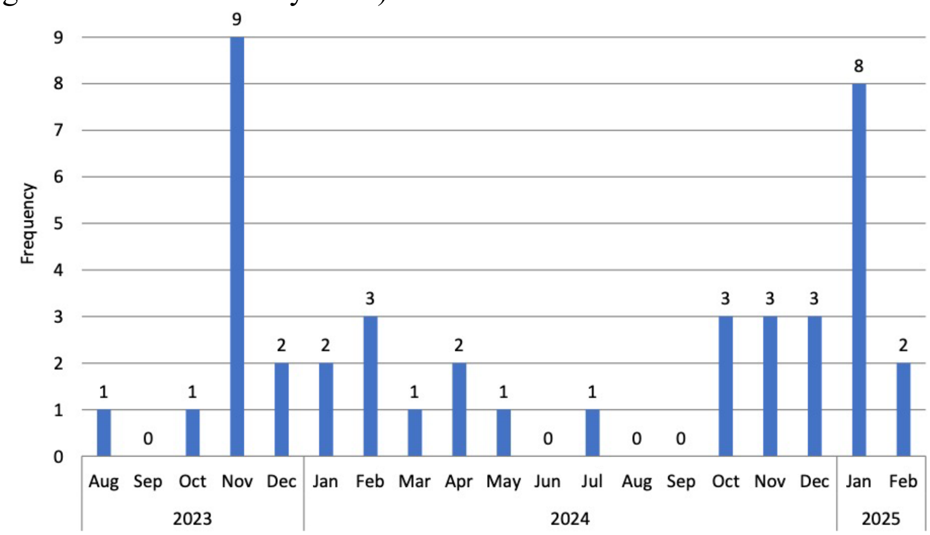


Figure 37 – Observed Pilot-prompts leading to a CAS-A Operation, Aug 2023 to Feb 2025

Some of the pilot prompts occurred after the controller had pointed out the traffic visually (via clock position and distance) and the flight crew asked about the TTF call sign. Typical pilot prompts are listed below.

- Pilots said something like, "Who should we designate?" or "Who are we following today?"
- Pilots asked for the TTF's call sign or asked if they "are following the Envoy?"
- Pilots reported the TTF designated (when not already instructed to do so) and asked if the controller wanted them to follow that aircraft.

While pilot prompts indicated the flight crew was prepared and willing to do the operation, they also could be prepared but not offer, or ask, to conduct a CAS-A operation. Being prepared could include a pre-briefing by the flight crew and the designation of an expected TTF. This "pre-designation" was tracked starting in May 2023. The flight crew was considered "pre-designated" if they reported traffic designated within about 10 seconds after a controller issued the traffic designation instruction. There was a total of 118 (14% of 836 attempted CAS-A operations logged between May 2023 and February 2025) observed operations where the flight crew was pre-designated. Figure 38 shows when those pre-designation observations occurred. The number of flight crew pre-designations observed may be an indication of how often flight crews were already using the ASA system to prepare for a CAVS or CAS-A operation or for increased traffic awareness. It may also reflect a desire by some flight crews to better identify the traffic they will follow on the approach.

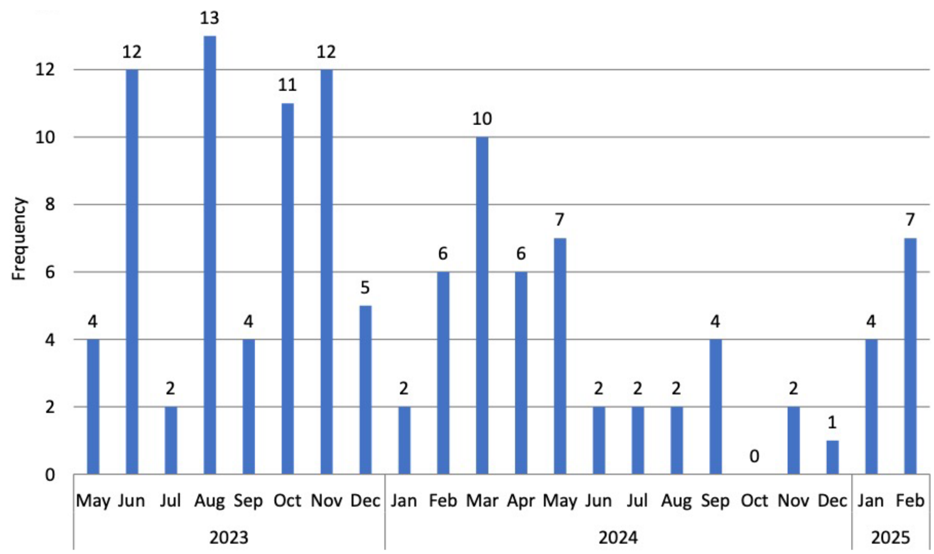


Figure 38 – Observed Flight Crew Pre-designations from May 2023 to February 2025

When a controller issued the traffic designation instruction, a flight crew was able to accept the instruction or reject/report being “unable.” As discussed in Section 3.1, most “unable” responses were tracked by having D10 controllers make a “ZP” entry when such events occurred. Controller-reported “unable” responses after May 2023 were reviewed using Falcon replay recordings and some of these “unable” responses were followed up by an APA Safety representative discussion with a member of that flight crew. In a few cases, flight crew “unable” responses were captured when observations were being made of sampled Falcon replay recordings (i.e., there was no “ZP” entry).

There were 94 unable responses logged in the CAS-A observations/feedback database during the operational evaluation. Figure 39 shows the frequency of flight crew unable responses when receiving the traffic designation instruction from a controller. Flight crew “unable” responses to the traffic designation instruction generally trended downward or remained low over the operational evaluation.

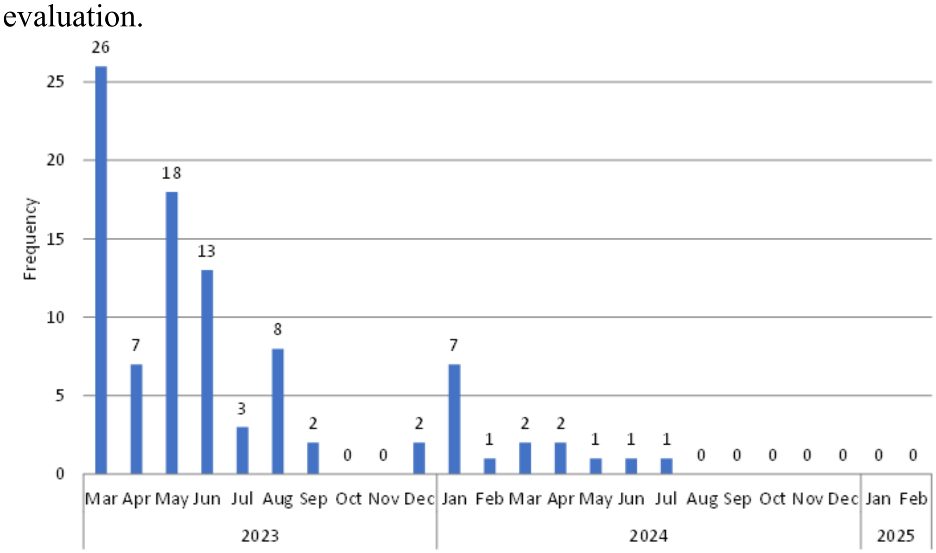


Figure 39 – Flight Crew “Unable” Responses to Traffic Designation Instruction

While there was no requirement for a flight crew to communicate why they did not accept a traffic designation instruction, reasons for any "unable" responses were of interest to the AIRS team because they could illuminate an issue that needed to be addressed. Of the 94 reported unable responses, 25 (27%) included a reason. Most reasons were reported via APA pilot feedback forms, but some were obtained as the result of a controller query or pilots offering a reason after reporting "unable." Figure 40 shows the 20 categories in which each of the 47 reasons provided were placed. Some pilots reported multiple reasons for a single "unable" response.

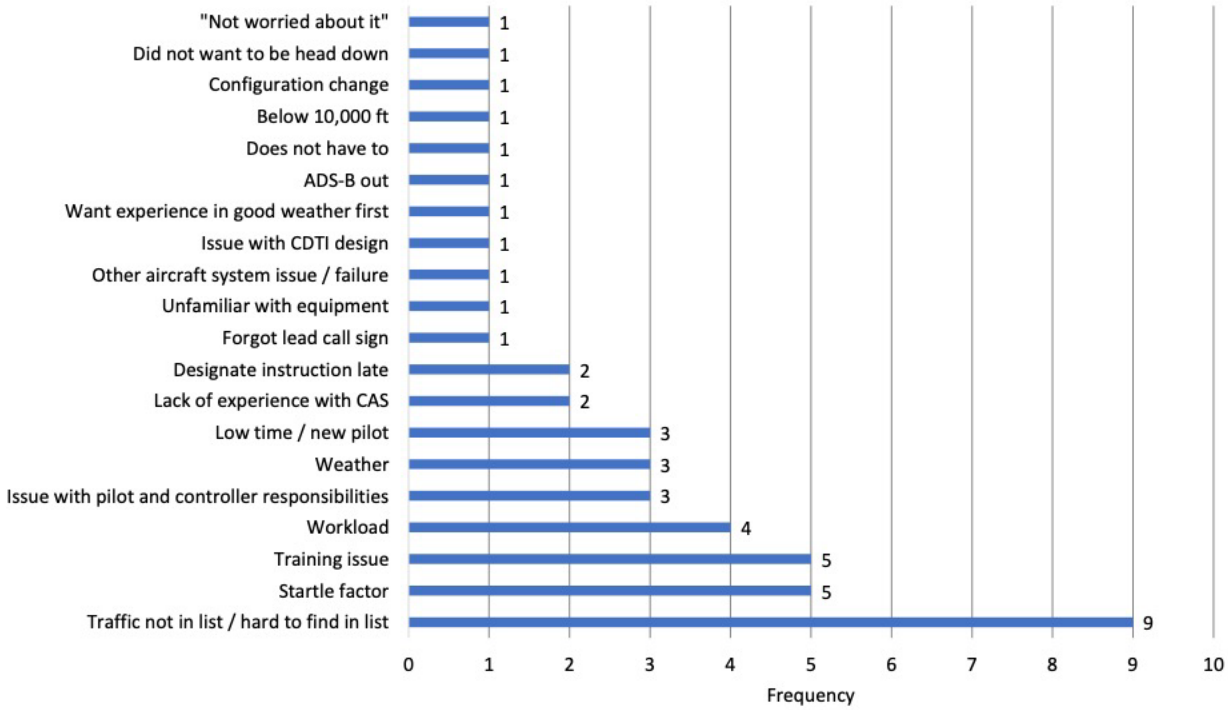


Figure 40 – Flight Crew Reasons for Responding to Traffic Designation Instruction with "Unable"

4.4.2.2 Traffic Designation Instruction Communication Issues

CAS-A operations were initiated by the traffic designation instruction, as noted in Section 2.7.1. The traffic designation instruction was specified in controller training, but beginning in August 2023, D10 controllers were also allowed to use an alternative phrasing, as described in Section 2.9. A mix of the two alternatives were observed after both were available. The new phraseology alternative was observed 52% (328/633) of the time between August 2023 and February 2025.

As permitted in all phraseology alternatives, some D10 controllers used different methods of communicating the TTF call sign to avoid potential confusion. An example of this was a controller saying "N K S" instead of "Spirit Airlines" so a flight crew receiving the traffic designation instruction would have the three-letter identifier to use with the ASA system and to insure that the TTF flight crew would not hear their own call sign.

Slight modifications to the phraseology alternatives were observed with at least one controller who "offered" a traffic designation instruction to a flight crew by using phrases like, "…if you want to do designated, let me know," "…advise if you would like to do designated," "…you want to designate the Heavy in front of you?", and "…advise designated [TTF call sign] if you want."

Overall, observed controller communications during the traffic designation instruction had very few issues. However, observed flight crew communications in response to a traffic designation instruction had issues and were tracked. After receiving the traffic designation instruction, the flight crew was expected to read back the instruction with the TTF call sign. If the flight crew already had the TTF designated[46], they could report that the TTF was designated (see earlier pre-designation results). If the flight crew did not have the TTF designated, they were to first read back the traffic designation instruction and later report that the TTF was designated.

Errors in flight crew responses to a traffic designation instruction were tracked closely starting in early June 2023 through the end of the operational evaluation (761 attempted CAS-A operations were logged in that period). Figure 41 shows the different issue areas that occurred and their prevalence in those 761 attempted CAS-A operations. A given attempted CAS-A operation could have multiple issue areas, so the percentages don't add up to 100 percent. Note the abbreviation "CS" is used for 'call sign' in this figure and others to follow.

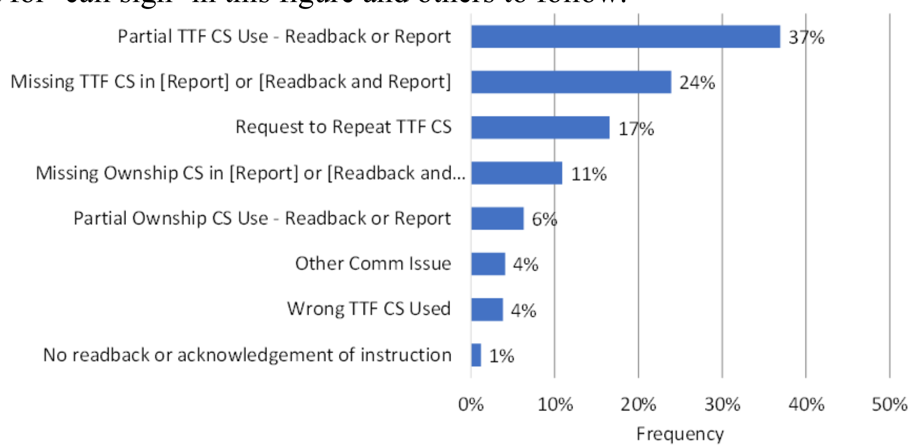


Figure 41 – Flight Crew Issues Responding to Traffic Designation Instructions

The most common issues were related to the flight crew not including, or including a partial, TTF call sign in either their read back of the traffic designation instruction or when reporting that the TTF had been designated. The next most frequent issue was a request for a controller to repeat the TTF call sign. The other issues were less frequent. Few of these communication issues led to further problems.

In addition to tracking the appropriate flight crew responses to traffic designation instructions, issues related to flight crews using the call sign of another aircraft (referred to as a third-party call sign[47]) in responding to the traffic designation instruction were tracked. Use of the wrong call sign of a third party (i.e., the TTF) by a controller could lead to flight crew confusion about which aircraft to follow when receiving a traffic designation instruction. Use of the correct call sign of a third party (i.e., the TTF) could lead to confusion for the TTF flight crew, who would hear their own call sign and wonder if an ATC instruction was for them. The use of two correct

[46] There was a requirement for coordination within the flight deck before reporting that the TTF was designated.
[47] See [22] for further information.

call signs (that of an aircraft receiving the traffic designation instruction and their TTF) in one communication could also be difficult or confusing for a flight crew receiving a traffic designation instruction, who must keep their own call sign and the TTF's call sign separate and clear in their mind. Managing two call signs from the same airline ("American" in this case) could be confusing as flight crews routinely change call signs with each new flight and any AAL flight number was a reasonable one for them to use.

These call sign communication issues were tracked starting in early June 2023, with 761 attempted CAS-A operations being logged from June 2023 until the end of the operational evaluation. There was call sign confusion in about 9% (69/761) of these attempted CAS-A operations. As shown in Figure 42, a flight crew responding to the traffic designation instruction was most frequently the party that had the call sign communication issue, followed by the TTF flight crew, and, much less infrequently, the controller. Figure 43 shows the categories of call sign confusion issues and their relative frequency of occurrence within the 69 attempted CAS-A operations.

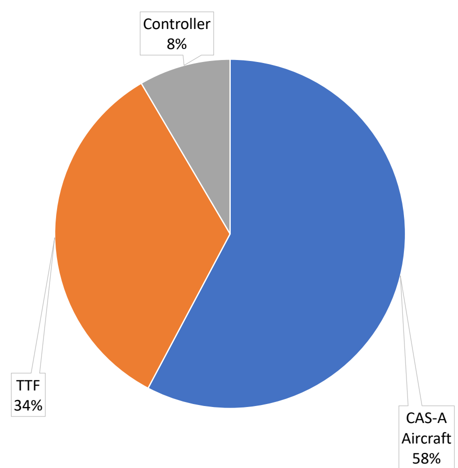


Figure 42 – Call Sign Communication Issues by Role

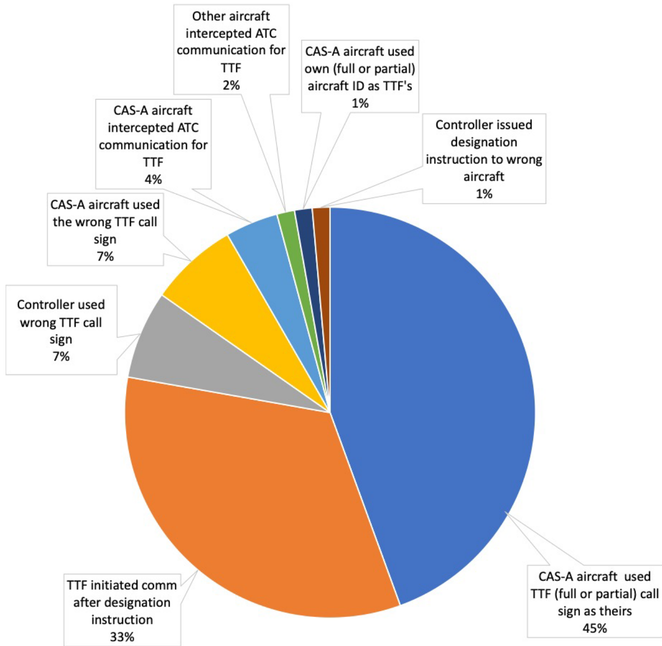


Figure 43 – Call Sign Communication Issue Categories

The most frequent (45%) issue was when a flight crew responding to the traffic designation instruction used all or part of the TTF call sign as their own, as shown in the following example:

CAS-A aircraft call sign: AAL 2635 **TTF call sign**: AAL 8214

Example response from flight crew: "American 82-35 'er American 26-35 has American 82-14 designated"

While the resolution of these issues was not specifically logged, the majority were observed to be quickly corrected by the flight crew in the same communication, or by the controller, and did not lead to a significant operational issue. No call sign communication issues led to a flight crew conducting a CAS-A operation following an incorrect TTF.

The next most common (33%) issue was when the TTF flight crew heard their own call sign and initiated a communication based on that. An example would be when a TTF heard their call sign in the communication between a controller and a flight crew during the Traffic Identification phase and said, "…was that for us?" These cases were all quickly resolved by the controller (including, in some cases, an explanation of why their call sign was used) and did not lead to further issues.

The wrong TTF call sign was used by a flight crew during the Traffic Identification phase in five (7%) cases and by the controllers in five (7%) cases. There were three cases (4%) where a flight crew conducting CAS-A heard an instruction from a controller for the TTF and replied to the controller as if the instruction to the TTF were for them (the flight crew conducting CAS-A). This was another case of the flight crew during the Traffic Identification phase confusing the TTF's call sign with their own. These cases were quickly corrected by the controller. The other call sign issues occurred less frequently, as shown in Figure 43.

Note that in the second year of the operational evaluation, D10 conducted a limited test of a call sign communication method which reversed the airline name and number of the call sign of the TTF (i.e., instead of "United 123", "123 United" was used). One D10 controller used this method for at least 10 CAS-A operations and that controller felt that it worked well but given the limited use of this method by a single individual, no firm conclusion was drawn. However, considering use of this method for referring to a TTF in a future operational evaluation might be beneficial in determining its effectiveness.

4.4.3 Conducting a CAS-A Operation

After traffic designation was successfully completed with a flight crew, a controller could issue the CAS-A instruction ("i.e., "follow traffic") after an approach clearance, in the same or a separate communication. For the 764 of the 938 operations with clearance data, Figure 44 shows that almost all the time (96.3%), D10 controllers issued the CAS-A instruction in the same communication with the approach clearance. There was one operation noted where the controller issued the CAS-A instruction before the approach clearance. This was counter to the CAS-A operational description that stated, "The CAS-A instruction must be issued after the issuance of the approach clearance, whether in the same or in a later transmission" (see page 18 of [24]). However, there were no further issues with that operation.

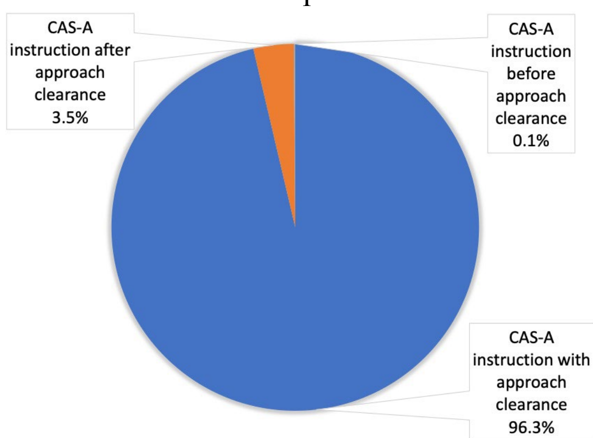


Figure 44 – Issuance of CAS-A Instruction Relative to the Approach Clearance

CAS-A operations were conducted during visual or instrument approaches. Of the 938 logged attempted CAS-A operations, 816 (87%) had an associated approach flown and had information about the type of approach issued. Of the observed CAS-A operations, 91% were conducted during visual approaches and 9% were conducted during instrument approaches. While instrument approaches were far fewer, the available data indicated no difference in CAS-A operations during instrument and visual approaches.

As described in Section 2.7.2, after the flight crew read back the CAS-A instruction to "follow traffic," controllers entered a code (IC or VC) in the STARS scratchpad to indicate the type of approach clearance that was issued. Observations of the CAS-A operations showed that VC and IC were sometimes entered in the scratchpad when either the Final or Feeder Controller received confirmation from the flight crew that the TTF was designated. In those cases, VC and IC remained in the scratchpad from traffic designation until the aircraft conducting CAS-A landed (provided the CAS-A instruction was issued and accepted).

One operation was noted where a partial traffic designation instruction was given to an AAL A321 aircraft without a CAVS-capable ASA system. The controller did a standard traffic point out and said, “report designated.” He did not use the TTF call sign. The flight crew said they were looking. A bit later, the controller pointed out the TTF without using the call sign again. The flight crew found the TTF out the window. The controller said, “follow designated traffic” and the flight crew said they would. VS (Visual Separation) was put in the scratchpad, which despite the controller’s phraseology, indicated that the controller understood that it was not a CAS-A operation. No other issues arose from the operation.

There were also three cases where a flight crew never reported the TTF designated or the CAS-A instruction was never issued by a controller[48], but VC was in the scratchpad. No other issues arose from these operations.

Prior to the Final Approach Fix, a D10 controller could issue a speed instruction to a flight crew conducting a CAS-A operation. Of the 938 logged attempted CAS-A operations, 764 (81%) had details on whether a speed instruction was issued. D10 controllers issued a speed instruction in 48% of the attempted CAS-A operations, while a speed instruction was not issued for the remaining 52% of the analyzed operations. Depending on the traffic configuration, a controller may have determined issuing a speed instruction was unnecessary (e.g., when there was a large distance between the aircraft conducting a CAS-A operation and the TTF) or a controller may have decided that the flight crew conducting CAS-A could effectively manage their own speed.

While it was not part of the CAS-A operation to achieve or maintain a specific distance from the TTF, there were 15 operations where a distance was mentioned. Five of these operations were on the same day. In each case the controller mentioned a particular distance (i.e., 3.0, 3.5, 6, no-closer-than 4, 2.5 miles) and asked the flight crew if that was something they could do. All but one flight crew acknowledged the distance request. After one of these operations was observed, D10 clarified for their controllers that managing a specific inter-arrival distance was not part of a CAS-A operation and should not be included in any CAS-A instructions.

The different aircraft types and operators of the TTFs were tracked in case there were any notable issues or trends that might be correlated with this information. Of the 938 logged attempted CAS-A operations, 798 (80%) had details on the TTF aircraft type and 681 (73%) had details on the TTF operator)[49]. As can be seen in Figure 45 and Figure 46, the prevalent TTF operator was AAL and the prevalent TTF aircraft type was A321.

[48] It is also possible there was a VHF audio gap in the Falcon replay system, since this was observed occasionally.
[49] This information could be derived from the aircraft data block shown in Falcon replay videos, which included the ICAO Aircraft Type Designator and the ICAO Three-Letter Designator (3LD).

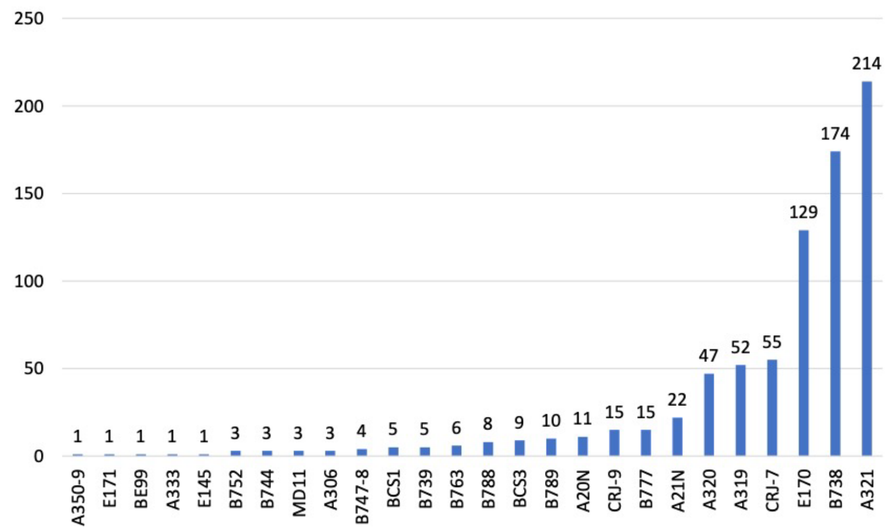


Figure 45 – TTF Aircraft Type for Logged Attempted CAS-A Operations

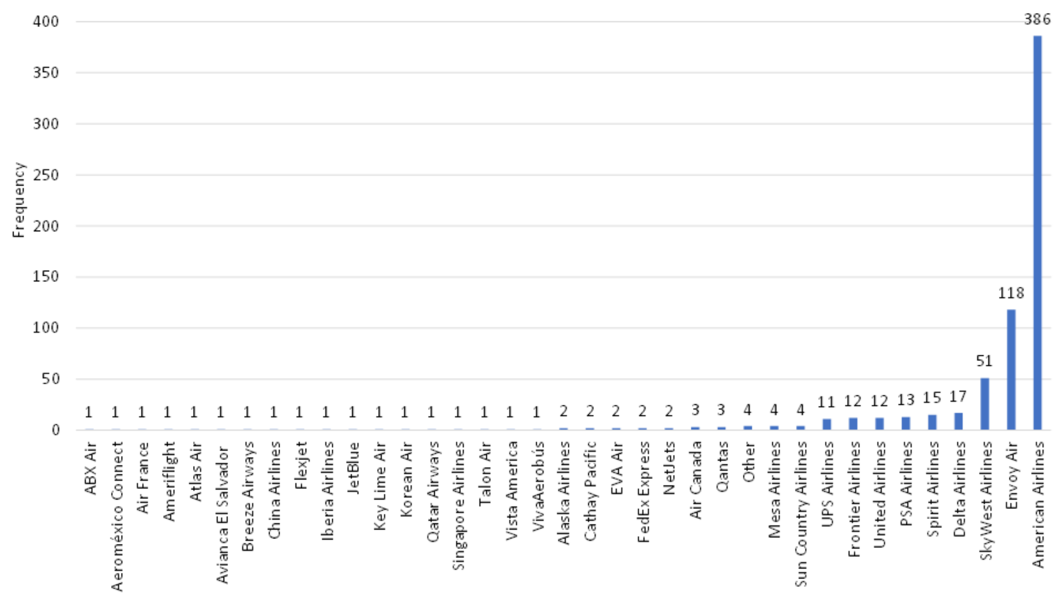


Figure 46 – TTF Airline for Logged Attempted CAS-A Operations

As noted previously, issues after traffic designation were limited. However, certain events could terminate a CAS-A operation. For example, a go-around or missed approach ended a CAS-A operation. Go-arounds and missed approaches were tracked in the FAA's PDARS database. During the operational evaluation, 17 go-arounds or missed approaches involved an aircraft conducting a CAS-A operation. That was less than 0.6% (17/3011) of the total CAS-A operations that occurred. Figure 47 shows when those go-arounds or missed approaches occurred. Each event was examined by the AIRS team, and these events were all determined to be caused by issues unrelated to CAS-A operations.

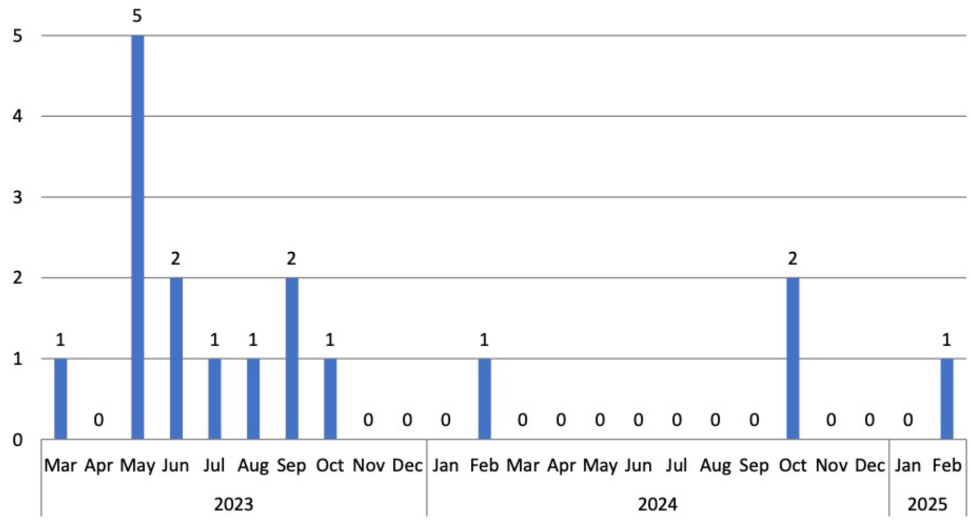


Figure 47 – Go-arounds and Missed Approaches During a CAS-A Operation

As shown in Figure 48, about 0.6% (6/938) of attempted CAS-A operations in the CAS-A observations/feedback database either canceled a CAS-A operation for reasons other than a go-around or missed approach. Four were due to the TTF being "lost" or no longer displayed on the MCDU or AGD (before or after the TTF was designated), which could have occurred due either an issue with a TTF aircraft's ADS-B Out information or an avionics issue on the aircraft conducting a CAS-A operation. One operation was declared a non-CAS operation based on controller feedback. The other operation was canceled by a controller for unknown reasons. All canceled operations occurred during visual approaches.

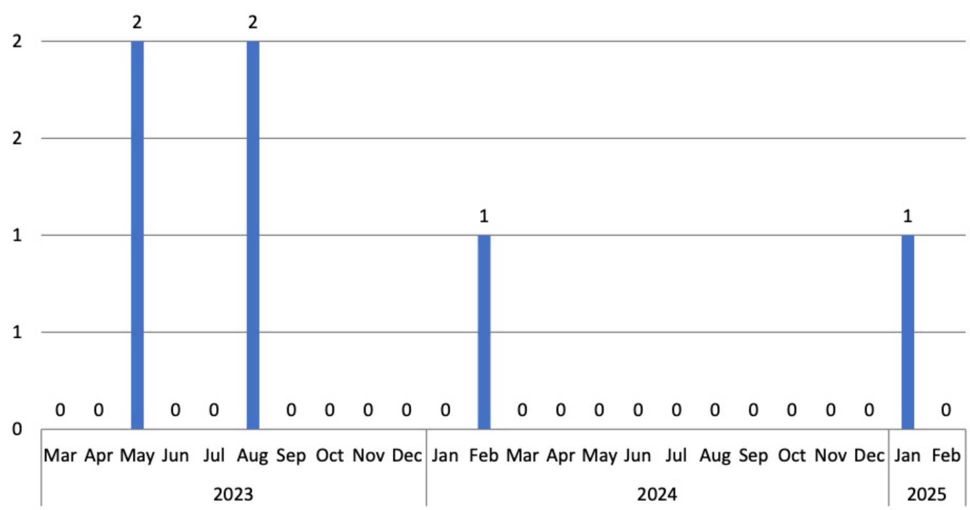


Figure 48 – Attempted CAS-A Operations Canceled for Reasons Other than Go-around or Missed Approach

4.5 Flight Crew Feedback from APA Interviews

Feedback was provided by 56 pilots on 44 attempted CAS-A operations via interviews by APA personnel. Note that the first five pilots interviewed by APA were asked a set of questions that were later updated for the remaining 51 pilots. Any differences in the questions between these two pilot groups is noted for the applicable question. Figure 49 shows when the flights occurred which were associated with the APA interview feedback forms submitted, indicating that most pilot feedback occurred during the first year of the operational evaluation.

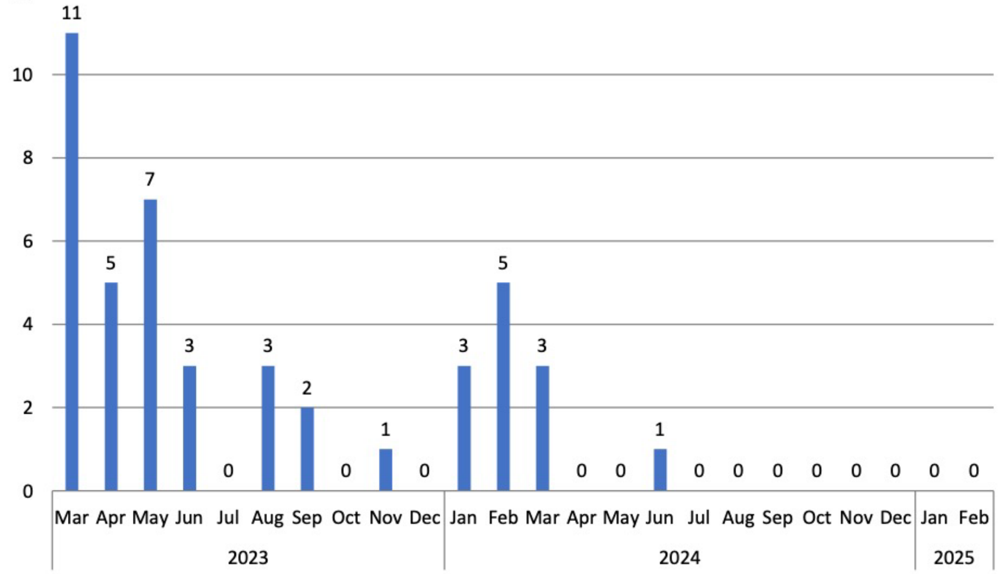


Figure 49 – Attempted CAS-A Operations by Month with Flight Crew Feedback

Both the Pilot Flying (PF) and Pilot Monitoring (PM) (24 pilots) provided feedback for 12 attempted CAS-A operations while only one pilot (PF or PM) provided feedback on the other 32 attempted CAS-A operations. It should be noted that most feedback sought from flight crews was to get additional information to “fix” or understand an issue (e.g., why a flight crew reported “unable” for a CAS-A operation). This was done because the time of the APA safety personnel conducting these interviews was limited and there was a desire to ensure the operational evaluation was running well and any issues were resolved quickly and thoroughly. As described in Section 2.13 and given the data in Sections 4.2 and 4.3, flight crew members had limited opportunities to experience a CAS-A operation. The feedback provided could be regarding the first CAS-A operation the flight crew experienced, which could have been challenging for them. Therefore, the feedback may have been skewed toward negative responses.

Flight crews were asked five questions for the specific CAS-A operation they conducted and then five additional questions on ASA system operations. Due to the high number of missing question responses, the figures in this section will show counts for pilot replies versus percentages of total replies. The number of missing replies will be noted for each question. Reply comments are put in order of frequency with the number of similar or identical comments provided in parentheses. The bullet/sub-bullet hierarchy was created by the analyst of this information only for comment grouping - any numbers in parentheses at the end of a bullet/sub-bullet are only for that specific comment.

4.5.1 Questions for a Specific CAS-A Operation

Flight crews were asked a question about their general experience with a specific CAS-A operation. Note that five of the pilots were asked about their “overall impression” and not their “general experience” since an older feedback form was used by APA for early interviews; however, the replies from these five pilots are included in all results. Eleven percent (6/56) of the replies to this question were missing or N/A[50]. The provided replies are shown in Figure 50. Twenty-four pilots reported a positive experience, 15 reported a neutral experience, and 10 reported a negative experience. One pilot chose a combined "positive and negative."

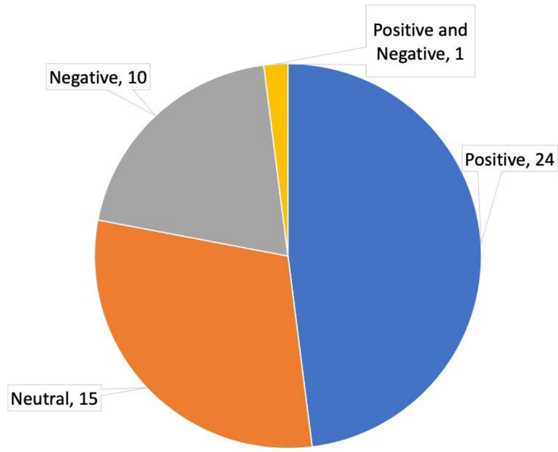


Figure 50 – Pilot Replies to "What was your general experience with this specific CAS-A operation?"

Pilots provided the following comments.

<u>Pros (or neutral)</u>

- Generally positive operation, e.g., "easy" (9)
  - Cleared for visual is a controlled visual – speed, heading, etc. Liked that it's up to the crew
  - Flight ID search made it easy
- System is useful (4)
- Adds situation awareness (4)
  - Nice to see overtake (2)
    - Changed speed to avoid overtake (2)
    - Kept up speed for compression
  - Particularly useful when following a regional jet that most often is the cause of a go-around
  - Knowing the TTF is helpful
- Pre-briefing the operation is helpful (4)
- Uses the ASA system often (3)
  - Always designates when following an aircraft
- Helpful to designate before getting controller instruction to designate (3)
  - Initiated the operation by reporting traffic designated to busy controller
- Has requested a CAS-A operation and was issued one by the controller (2)
- Read ahead to be prepared
- Hazy conditions where traffic was not found visually out-the-window so traffic was designated. Controller then gave instruction to designate the same traffic
- Eases radio congestion
- Receiving the traffic designation instruction is helpful

[50] Since flight crew feedback forms were completed by APA safety personnel after a discussion with a pilot, the lack of response information could indicate that this question was not asked during the discussion. Additionally, "N/A" could indicate that the interview discussed a flight crew "unable" response, since no CAS-A operation occurred.

- Pilots use it more when it becomes familiar
- Wish all aircraft had the ASA system

Cons (or topics to consider)

- Getting the traffic designation instruction late in the airport pattern is challenging (8)
  - Particularly the first time
  - Leads to head-down time and increased workload[51]
  - Did not like the clearance on approach
- Difficult when the other flight crew member is new to the airline or aircraft (5)
- Surprised by the traffic designation instruction (5)
- Difficulty finding TTF call sign in traffic list (4)
- Expected to get more details from the controller on what to do (e.g., distance to achieve/maintain) (5)
- Need more/different training (3)
- Not able to note the TTF call sign when issued (2)
- Difficult when already in a high workload situation (2)
- Shifting responsibility to flight crew (2)
- A mention of distance from the controller led the flight crew to select another operation (i.e., the Spacing application in the SafeRoute+ system[52])
- Interface is challenging
- First time is challenging
- Was stressful
- Rapid clearance

Another question for flight crews was whether they had any challenges with the specific CAS-A operation. Note that five pilots were not asked this question since an older feedback form was used by APA for the early interviews. Eighteen percent (9/51) of the replies to this question were missing or N/A. Twenty-two pilots said they did and 17 said they did not. Several comments for this question referred to the comments for the previous question. All the issues mentioned for this question were noted in the previous question.

Another question for flight crews was whether the CAS-A phraseology was explicit and understandable. Note that five of the pilots were not asked this question since an older feedback form was used by APA for the early interviews. Those five pilots were asked if they had any issues with the phraseology. Their replies are not included in the figure, but their comments are included. Twenty-nine percent (15/51) of the replies to this question were missing or N/A. The replies provided are shown in Figure 51. The majority (32) reported that the phraseology was explicit and clear. Those that said, "no" as part of their reply reported the following issues.

- Expected to get more details from the controller on what to do (e.g., distance to achieve/maintain) (3)
- Did not know it since they had not prepared (2)
- Would like more warning that the traffic designation instruction is coming (2)

[51] This was an initial concern of some pilots, but this issue did not come up after pilots became more aware and familiar with the SafeRoute+ system and its operation.
[52] During much of this operational evaluation, AAL flight crews were also participating in an I-IM operational evaluation in Albuquerque Center; see [25] for further details.

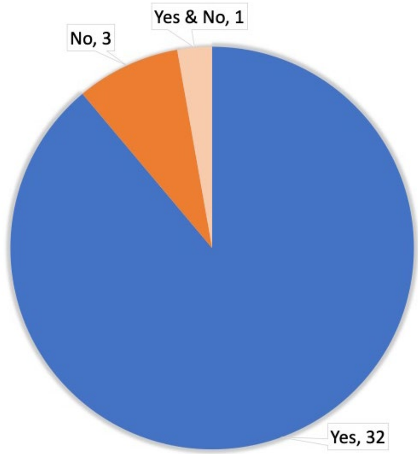


Figure 51 – Pilot Replies to "Was the CAS-A phraseology explicit and understandable?"

Another question for flight crews was whether they had any feedback on the avionics interface. Note that five of the pilots were not asked this question since an older feedback form was used by APA for the early interviews. Those five pilots were asked if they had any issues with the avionics interface. Their replies are not included in the numerical results, but their comments are included. Twenty-five percent (13/51) of the replies to this question were missing or N/A. Fifteen pilots said they did and 23 said they did not. Comments that are more broadly applicable to a general avionics design are provided below.

- Would be easier if the AGD information was integrated into the ND (6)
- AGD location is challenging (2)
  - Viewing for pilot in right seat is challenging (3)
- Finding the TTF on the MCDU traffic page was challenging[53]
- Would like to see TTF type[54]

Another question for flight crews was whether any additional information would have been helpful in training. Twenty-five percent (14/56) of the replies to this question were missing. Seventeen pilots said there was additional information that would have been useful and 25 said there was not.

The following ideas for improvement or general comments were provided.

- Learned with experience (8)
  - Including before being asked to do it (2)
- Pilots need to review the material (8)
  - Material is good to review after having conducted an operation
- Bulletin is insufficient (4)
- Training was limited (3)
- Would like to see other training (2)
  - Would like to see in recurrent training (3)
  - Hands-on training needed (3)

[53] There was a 'search' function in the MCDU traffic page that many pilots did not seem to realize was there; many pilots reported scrolling down through an MCDU traffic list that was ordered by horizontal range from the ownship.
[54] Note that Aircraft Type is not available in ADS-B version 2 ([E]TSO-C166b) or prior ADS-B versions, so such information was unavailable to the ASA system.

    - Videos are helpful (3)
    - CCI memos are effective (3)
    - Simulator scenario would help (2)
    - Demonstration would be beneficial
    - An app[55] would be helpful
    - Would prefer a procedures training tool
    - Needed in full motion simulators
    - Having it explained during Initial Operation Experience flights would be beneficial
- Challenging when review of material occurred long before conducting the operation (2)
- Quick reference card would help (3)
    - Would like a paper quick reference card to grab (versus the quick reference guide provided on the iPad)
- Reading is not enough
- Need to know what to do when have a speed from the controller and compression is observed
    - Following the TTF without a specified distance
- Guidance on searching for TTF call sign
- Material has a long-drawn-out explanation - should be simplified and reference what we already do with TCAS
- Details on how to incorporate this[56] into the normal scan/use

4.5.2 Questions on Use of the ASA System

There were five additional questions that a pilot could be asked on the use of the ASA system for purposes other than CAS-A operations. The first question asked flight crews if they conducted CAVS operations to gain comfort with the ASA system. Note that five of the pilots were not asked this question since an older feedback form was used by APA for early interviews. Twenty-two percent (11/51) of the replies to this question were missing. Thirty-three pilots reported conducting CAVS operations to gain comfort and seven did not report doing so.

The following bullets provide highlights of the comments about how the ASA system was used:
- For greater situation awareness (terminal and en route) (10)
- To become/stay familiar (3)
- To designate traffic (3)
- To monitor speed (3)
- For weather avoidance (2)
- At CLT (2)
- At PHL
- At Seattle–Tacoma International Airport (SEA), where spacing from lead can be close
- To monitor for overtakes to notify the controller
- After hearing holding instructions for other aircraft, used the ASA system to display traffic to see their holding location and exit point to preplan for holding
- To monitor call signs

[55] While not specified beyond “app”, this comment could refer to a training application or job/procedure aid for company-provided iPads used as Electronic Flight Bags.
[56] It was unclear if the pilot was referring to the AGD, the MCDU traffic page, or both.

Another question for flight crews was whether they behaved differently when following traffic and using the ASA system than they did when following traffic and not using the ASA system. Forty-five percent (25/56) of the replies to this question were missing or N/A. Eighteen pilots reported behaving differently and 13 did not report doing so.

The following bullets provide highlights of the comments recorded.

- For speed and overtake awareness, and adjustments (8)
  - Without it, tendency is to slow sooner than needed (2)
- Use now instead of TCAS (4)
- More detailed/accurate information (4)
- More aware of instantaneous information (2)
- Miss the ASA system when in aircraft that do not have it (2)
- More confidence/comfortable compared to visual (3)
  - See exact distance
- More head-down time
- Have become more diligent about separation
- To differentiate between traffic
- To discuss closure and proximity to traffic that normally does not occur when looking out the window
- Changed scan from out-the-window to the AGD
- Doing something different might be against what the controller is expecting
- To listen to frequency changes for other aircraft and to know the frequency in advance
- To make better decisions
- Does not feel much different. Have always used TCAS

Another question for flight crews was whether the ASA system helped when following traffic. Forty-eight percent (27/56) of the replies to this question were missing or N/A. Most pilots (26) said the ASA system helped when following traffic and three said it did not.

Of the three pilots that said it did not, one said he/she had a technique that worked and did not use the ASA system much. A second pilot said he/she mainly used the ASA system to observe the overall traffic environment. The third pilot did not provide a comment.

The following comments were provided on how the ASA system helped. Note that several comments pointed to replies from the previous question on behaving differently.

- For increased situation awareness (4)
  - Going into MIA (Miami International Airport)
- Speed information is useful (4)
- Makes it easier to be aware of potential go around situations (2)
  - Detected situation where the arrival operation may not work out due to proximity to aircraft ahead; designated traffic which validated the concern and took action to slow down - essentially prevented a go around
- Situation awareness on departure where the TTF is monitored until paths diverge
- Distance information is helpful

- Used to observe an overtake on an aircraft during descent that would have potentially resulted in a TCAS event. Notified the controller (who may not have been aware) who vectored the other aircraft to avoid the overtake
- To determine whether the Airbus Ground Speed Mini[57] will be a factor in closure
- Better planning
- Better decision-making with accurate information
- Avoiding slowing too early
- Increases confidence with separation
- Easier to tell if there is too much overtake
- To watch other flight crew's routes around weather

Another question for flight crews was whether the ASA system enhanced safety. Note that five of the pilots were not asked this question since an older feedback form was used by APA for early interviews. Twenty-nine percent (15/51) of the replies to this question were missing. The provided replies are shown in Figure 52. Thirty-two pilots said the ASA system enhanced safety and three said it did not. One pilot said it both did and did not.

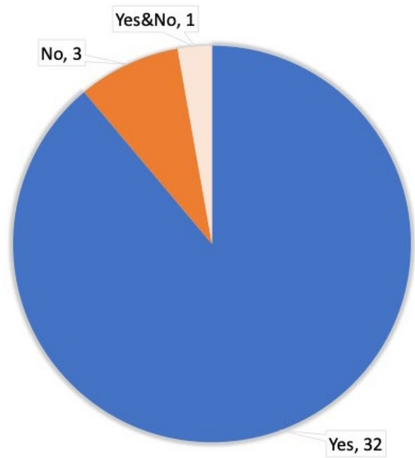


Figure 52 – Pilot Replies to "Do you believe the CDTI is an enhancement to safety?"

The following comments were provided.

- Increased situation awareness (9)
  - Awareness of distance to TTF and trends; guessing when visual only
- Too soon to tell (6)
- More information (3)
- An enhancement (3)
- More so as get familiar with it (3)
- Concerned if it means more responsibility for pilots (3)
- Head-down time could be issue (2)
- No, but efficiency will improve
- Instantaneous traffic is good
- Prepared to do a go-around
- Less chance of a go-around

[57] See pages 23-24 in [28] for information about this Airbus function.

- Helps when controller gives a speed that may not work, especially with a regional jet; may be aware before controller
- TCAS is wonderful; this is a close second
- Can be if not a distraction
- May be concern if last minute clearance close to airport
- Controller is getting more accurate separation
- Can be workload intensive, but may get better with proficiency
- Does not add workload and benefits are large

Another question for flight crews was whether they found the advisory traffic range alert useful. Sixty-four percent (36/56) of the replies to this question were missing. Eight pilots found the traffic range alert useful and 12 did not. The comments provided include the following.

- Not familiar with it (10)
- Aware but have not seen it activated (3)
- Has seen it activated but not familiar with it (2)
- Accurate and helpful/useful (2)
- Enhances situation awareness of the TTF
  - Gives a heads up
- Not needed
- Familiar with it

Based on inter-arrival distance data (see Section 4.2.3), there were a limited number of aircraft that got close enough (within 2.5 NM) to the TTF to have the traffic range alert triggered[58], so pilots having limited awareness of the advisory traffic range alert was not surprising.

4.6 Controller Feedback on CAS-A Operations

As mentioned previously, controllers were able to provide their feedback for a particular CAS-A operation. As with the flight crew data, the feedback was likely provided when there was a situation that needed to be addressed. Therefore, abnormal or problematic operations are likely overrepresented in this data as well.

4.6.1 Information from Controller Feedback Forms

Controllers provided feedback on 35 operations. Figure 53 shows when the flights occurred that were associated with each feedback form. As can be seen, most controller feedback forms were received for operations in the first month.

[58] As described in Section 2.5.2, the default value for the traffic range alert was 2.5 NM, but pilots could set the traffic range alert to a different value. This statement presumes that the default value was not changed.

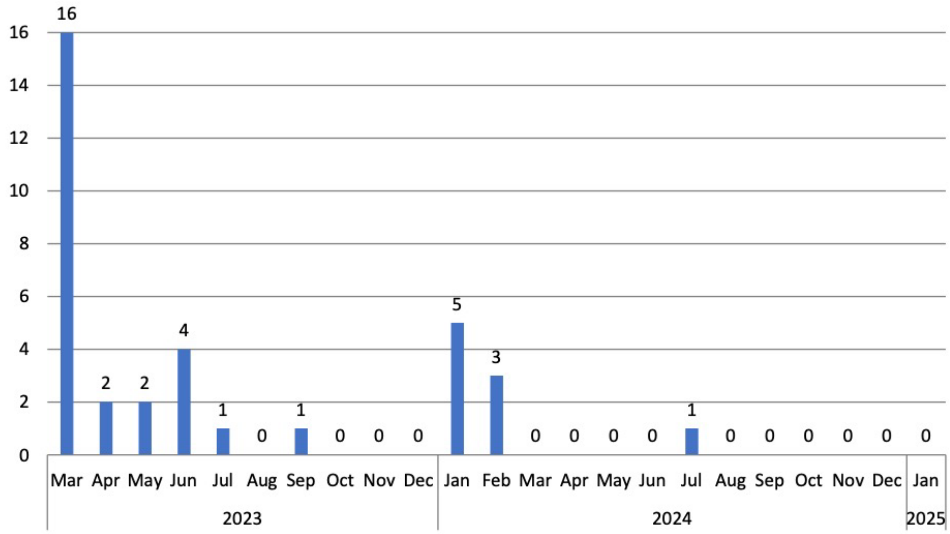


Figure 53 – Controller Feedback Forms by Month when CAS-A Operation Occurred

Thirty-one of the 35 controller feedback forms (89%) were reporting an issue and four were not. Figure 54 shows the reasons provided and those without a reason were marked "None".

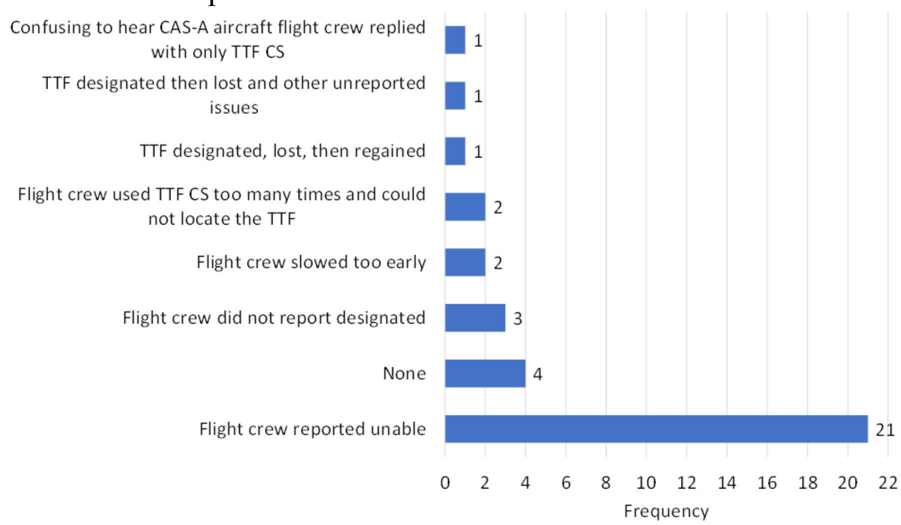


Figure 54 – CAS-A Operational Issues Reported via Controller Feedback Forms

Most controller feedback comments were related to a flight crew reporting being unable to comply with the traffic designation instruction. The other issues were related to topics related to flight crews: not reporting that the TTF was designated, slowing too early, use of the TTF call sign too often, unable to locate the TTF using the ASA system, and confusing use of call signs. Four (11%) feedback forms did not report an issue.

Controllers were asked two questions on the form. First, controllers were asked about their overall impression of CAS-A operations. For the four forms without a reported issue, all controllers reported their overall impression as "positive." Of the 31 forms with a reported issue, five replies were missing. For the rest, as shown in Figure 55, controllers reported their overall impression as negative (6), the majority as neutral (16), positive – neutral (1), and positive (3).

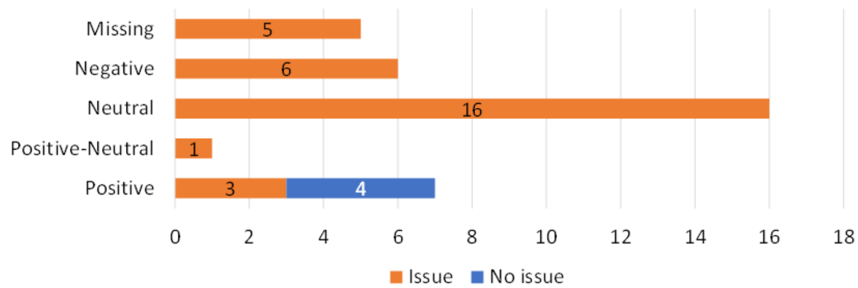


Figure 55 – Controller Replies to "What was your overall impression of CAS-A?" by whether an issue was also reported

The controllers were also asked to report whether CAS-A operations were: Useful, Helpful, Neither, or Unknown. Figure 56 shows a mix of replies based on whether the controller reported an issue for the operation. For the four forms without a reported issue, controllers reported their impression to be unknown (1), neither useful nor helpful (1), useful (1), and useful and helpful (1). Of the 31 forms with an issue, five replies were missing. For the rest, controllers reported their impression to be unknown (6), the majority as neither useful nor helpful (17), useful, helpful, and neither (2), and useful and helpful (1). Zero replies were provided for helpful or useful in the forms with a reported issue.

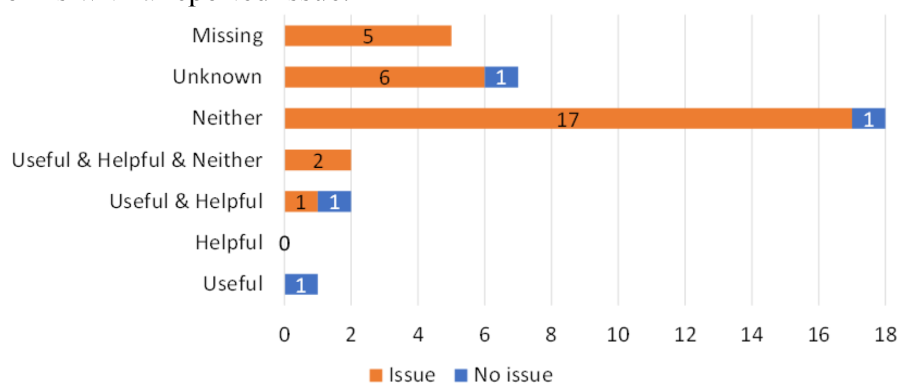


Figure 56 – Controller Replies to "CAS-A was:" by whether an issue was also reported

Besides the feedback provided in these controller feedback forms, the feedback from the D10 facility during periodic AIRS team meetings was that procedural changes (e.g., the approval of widely-spaced parallel operations on the outboard runways) put in place after the operational evaluation began reduced the controller benefits of CAS-A operations at D10. D10 controllers reported that they saw some benefits (e.g., the ability to reduce the downwind flight distance significantly by moving the aircraft into what would have previously been an unused or partially unused gap in the arrival flow) and wanted to continue using it. D10 controllers also said they believed CAS-A operations would have benefits (e.g., reduced IAT/IAD) for other airports in the NAS. They reported potential initial resistance from D10 controllers, and lack of use, because CAS-A operations were new, but a major challenge was knowing which aircraft were eligible without capability indicators on their STARS display and the limited number of eligible aircraft. D10 controllers said capability indicators and more eligible aircraft were necessary before a larger number of operations could be expected.

4.6.2 Information from Directed Discussions with D10 Controllers

As stated in Section 3.6, in November 2024, discussions with D10 controllers were accomplished in two ways; via controller crew breakouts and while monitoring operations in the control room. Some controller crews were more receptive to CAS-A operations than others. There were comments that all controller crews voiced regardless of their enthusiasm level towards CAS-A operations. As noted in Section 4.3, there were only about 5-10 controllers at D10 who really embraced CAS-A operations and saw the benefits, so these sessions involving all D10 controllers tended towards critical commentary. The following summarizes these conversations.

A consistent comment from almost every controller was that when they were busy, they did not think about CAS-A operations, and that could change with more equipped aircraft. CAS-A operations were not a tool they thought of using when they were busy, they used other familiar tools that they didn't have to necessarily think about. In the event more aircraft equipped for CAS-A operations, a capability indicator for STARS would be mandatory.

All controller crews mentioned that during busy periods, trying to initiate a CAS-A operation broke their rhythm of working the traffic. They consistently used the same headings and altitudes without having to think about such clearances. Attempting a CAS-A operation during a busy period required the controller to think about a different clearance with different phraseology which could break up their rhythm working the arrival/approach traffic feed. This was a key component for many controllers in deciding to not use CAS-A operations during peak traffic periods.

All controller crews mentioned that visual separation was not (or very rarely) used at D10, thus adding an extra clearance with different phraseology wasted precious time.

The approach control airspace was very dynamic, and controllers needed to give many clearances in rapid succession to keep the flow of traffic safe and efficient. All controllers mentioned that they did not have time to add extra phraseology. Most controllers added that CAS-A operations may be of benefit to facilities that are not as busy as D10.

Most controllers added that they could do the approach spacing better themselves[59] and did not need any assistance from the flight crew. Controllers also stated that they have tools to use that were less disruptive to their rhythm than a CAS-A operation.

One of the expectations of CAS-A operations was that flight crews would have better situational awareness and thus aid in the compression on final. Several controllers stated that they had seen or were concerned that flight crews would unexpectedly slow their aircraft, which would create issues with traffic following the CAS-A operation.[60]

A high percentage of controllers mentioned that more equipped aircraft may help. There was a small percentage of controllers that stated CAS-A operations were good during hazy conditions.

[59] While this was stated by D10 controllers, the objective data from Section 4.2 appeared to challenge this assertion.
[60] While this was an understandable concern, there was no observation of this behavior during the operational evaluation.

One controller stated he was uncomfortable giving a visual approach to an aircraft that did not see the runway and to follow an aircraft that the flight crew did not see out the window.

Most breakout sessions began critical of CAS-A operations, but as the discussions ensued and more thoughts were exchanged, there was some sense that higher CAVS-capable equipage and at a facility that used visual separation, CAS-A operations would likely provide a benefit.

5 Lessons Learned and Recommendations

There were several lessons that were learned from conducting CAVS operations and the CAS-A operational evaluation. Some of the more significant lessons and recommendations are outlined below.

5.1 CAS-A Operational Evaluation Approach and Focus

AIRS team members often reflected on the value of conducting an operational evaluation versus a flight test or a flight demonstration. This approach allowed both the FAA and industry to manage the risks associated with introducing new technologies and operations into the NAS. The approach used for this operational evaluation allowed the FAA and industry to make modifications based on the data obtained and then evaluate those modifications. The collaborative reviews and problem-solving were key to making this operational evaluation successful.

5.2 ATC Automation Support for CAS-A Operations

The AIRS project intentionally did not make any modifications to STARS or the Time-Based Flow Management (TBFM) system. The objective was to evaluate the benefits and operational feasibility of CAS-A operations before investing significant resources in the development of ATC automation upgrades.

However, the lack of a capability indicator in STARS made it difficult for controllers to easily identify aircraft capable of conducting CAS-A operations. This lack of a capability indicator also made it less likely that most controllers would remember to initiate a CAS-A operation.

The small (but statistically significant) reductions in flight time and distance in the terminal area related to CAS-A operations were encouraging. However, this benefit would be limited if aircraft were not available to fill the gaps created in the arrival traffic flow if CAS-A operations were used consistently.[61] If properly incorporated into TBFM, the ability of CAS-A operations to reduce the average and variation of the IAT and IAD has the potential to significantly increase airport throughput and reduce arrival delay[29].

Use of the STARS scratchpad appeared to work well for both denoting traffic designation for a Final controller (to remind themselves that the flight crew reported the TTF was designated) or for a Feeder controller to notify a Final controller that traffic designation occurred in the Feeder controller's airspace. It also appeared to work well (as originally intended) for a Final controller to inform a Local/Tower controller that a CAS-A operation was underway. If VC and IC were in the scratchpad indicating that the TTF was designated, but the flight crew was unable to "follow traffic" or the controller did not issue the CAS-A instruction, VC and IC needed to be cleared from the scratchpad, so the Local/Tower controller would know the appropriate separation minima. This did not appear to be an issue during the operational evaluation, but a quick and

[61] This also assumes that airlines would equip their aircraft with CAVS-capable ASA systems, as AAL did for this operational evaluation.

easy method for controllers to share CAS-A operational status should be considered for future ATC automation implementations.

5.3 ATC Considerations for CAS-A Operations

A CAS-A operation was initiated when a controller instructed an aircraft flight crew to designate a TTF; this could be done by either a Feeder or a Final controller. In the operational evaluation, most traffic designation instructions were issued by a Final controller. However, it may be desirable to have a Feeder controller issue the traffic designation instruction to the flight crew because a Feeder controller's airspace is typically a lower workload environment for flight crews than a Final controller's airspace close to the runway. A challenge for a Feeder controller in issuing the traffic designation instruction occurs if a Feeder/Final pair of controllers assumed a different sequence of aircraft arrival. When the arrival sequence is obvious (e.g., one flow to a runway), it is desirable for a Feeder controller to issue the traffic designation instruction to allow flight crews more time to prepare for a CAS-A operation. If a Final controller must issue the traffic designation instruction, this should occur as soon as possible after a flight crew checks in on the frequency.

While some flight crews expressed an expectation of getting a distance goal from a controller and some controllers attempted to give flight crews a distance goal (flight crews generally accepted them), flight crews were not trained for achieving or maintaining a defined distance from the TTF. The CAS-A operational description does not describe such an operation[24]. If terminal area controllers want an aircraft to achieve a specific spacing goal on an approach, then Interval Management[30][31] would be the most appropriate ASA to utilize.

5.4 Pilot Training for CAS-A Operations

Most issues during CAS-A operations occurred in flight crew communications in response to a controller's traffic designation instruction. The flight crew not including the TTF call sign in their reply to the traffic designation instruction could lead to confusion about whether the correct TTF was being followed. Additionally, not including the ownship (aircraft conducting CAS-A) call sign could lead to confusion on the part of the controller about who is replying. Since managing two call signs can be challenging, the importance of proper use of full ownship and TTF call signs should be part of flight crew training. Flight crew training should also emphasize minimizing requests for a controller to repeat a TTF call sign.

Using a call sign of an aircraft that is being spoken about versus spoken to has the potential to cause confusion. For example, use of the wrong call sign by the controller can lead to flight crew confusion about which aircraft to follow. Use of the call sign of the TTF can lead to confusion for the TTF flight crew who could hear their own call sign and believe an instruction was for them. As such, call sign confusion should be part of flight crew training. The topic has been studied in detail in the past[22].

5.5 Considerations for ASA System Flight Crew Interface

In the operational evaluation, pilots reported some difficulty in locating the TTF in the MCDU traffic page, sometimes due to having to scroll through a traffic list whose default ordering was by slant range from ownship. AAL reminded pilots that a search function was available within the MCDU traffic page that allowed for flight crew entry of the TTF call sign number so that the SafeRoute+ system would filter the list based on each call sign character entered, to enable quicker searches. This information was reported as helpful by pilots and reported issues with locating the TTF subsequently decreased. While not specified in ASA system standards for CAVS, a traffic search/filter feature should be considered by other ASA system manufacturers to help flight crews quickly find the TTF call sign to minimize workload.

Comments that AAL pilots made on the ASA system flight crew interface that are broadly applicable to ASA systems supporting CAVS (and CAS-A) in general indicate a desire to have the ASA traffic display in a location that works well for both pilot positions and integrated with the installed ND. This comment has been received in numerous other ASA system research efforts[4][32]. Integration with the installed ND should be considered for forward-fit implementations.

6 Conclusion

The ADS-B In Retrofit Spacing (AIRS) project collected data on the value of Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS) in large-scale operation over a multi-year period. CAVS operations were approved by the FAA in May 2021 for American Airlines (AAL) flight crews to use in equipped aircraft wherever appropriate conditions exist. AAL flight crews continue to conduct CAVS operations in equipped aircraft.

The AIRS project also evaluated the operational feasibility and value of Cockpit Display of Traffic Information (CDTI) Assisted Separation on Approach (CAS-A) operations at Dallas-Fort Worth International Airport (DFW) over a two-year period. This was accomplished via a partnership of the Allied Pilots Association (APA), AAL, Dallas-Fort Worth Terminal Radar Approach Control (TRACON) Facility (D10), DFW Tower, Aviation Communication & Surveillance Systems, LLC (ACSS), Federal Aviation Administration (FAA) organizations and their support, and the National Air Traffic Controllers Association (NATCA).

These partners met and discussed on-going operations, solved any issues, considered improvements, and reviewed data. Data was collected and analyzed from several sources, including FAA data sources, Aircraft Surveillance Applications (ASA) system data, D10 controller feedback forms, and APA flight crew feedback forms.

Utilization and impact data for CAVS operations were analyzed from January 2022 to the end of December 2023 at six AAL hub airports. IAT and IAD results were presented at six airports where AAL A321 flight crews designated traffic, as well as flight time and distance results in the terminal area for CAS-A operations at DFW. The key findings were:

1. When flight crews used a CAVS-capable ASA system, they tend to achieve more consistent and smaller interarrival distances at the runway threshold, which can increase runway throughput.
2. When flight crews used a CAVS-capable ASA system and TRACON controllers recognized capable aircraft and initiated a CAS-A operation, there were flight time and distance savings in the terminal area.

While the average IAT and IAD decreased when flight crews designated traffic, the minimum IAT/IAD did not significantly change; this suggested that flight crews were better able to achieve a distance they are comfortable with based on the ASA system's CAVS functionality and were not trying to get closer to the TTF than current minimum distances. Shifting the average IAT and IAD closer towards the minimum values results in an increase in average throughput, allowing better use of the existing runway capacity.

From March 1, 2023 to February 19, 2025, there were 3,011 successful CAS-A operations. During this same period, 938 attempted CAS-A operations were reviewed, with observations and available pilot/controller feedback recorded in the CAS-A observations/feedback database. Data was collected on the operational feasibility and impact of the CAS-A operation.

A review of sampled CAS-A operations indicated that the defined procedures, phraseology, and flight-deck interface were acceptable and that such operations worked equally well during visual and instrument approaches. The use of a speed instruction at the discretion of a controller to manage the spacing between an aircraft conducting CAS-A and their TTF appeared to work as well as it does with conventional pilot-applied visual separation operations. The percentage of flight crews that declined or were unable to conduct a CAS-A operation was generally low and no go-arounds were caused by a CAS-A operation.

Most of the challenges during CAS-A operations occurred in the communications associated with flight crews designating the TTF and were often related to the use of call signs. For example, flight crews conducting a CAS-A operation sometimes mixed the TTF's call sign with their own when reading back instructions to a controller. Some TTF flight crews heard their own call sign in the controller's traffic designation instruction and asked if a communication was for them. Communication issues were reduced by modifying the traffic designation instruction phraseology, which reduced the number of times a TTF's call sign would be used. When communication issues occurred, they were resolved quickly either by the flight crew or the controller. No issues led to an aircraft conducting a CAS-A operation following an incorrect TTF.

Most pilots reported a positive to neutral experience with CAS-A operations. The most noted issues were challenges related to being surprised by the controller's traffic designation instruction and initially performing a new flight deck task. Many issues were mitigated by providing awareness to D10 controllers, increased experience with CAS-A operations by flight crews, and timely AAL bulletins to pilots that provided necessary information to mitigate the issues.

For both CAVS and CAS-A operations, pilots reported the benefits of added traffic awareness for avoiding overtakes, go-arounds, and slowing earlier than necessary. Pilots generally found the ASA system acceptable, but several pilots reported the need for improved training beyond the initial training bulletin. AAL addressed this by providing iPad-based simulation tools, instructional videos, and special briefings during recurrent ground school and simulator training.

Documented controller feedback was limited, but some D10 controllers conducted numerous CAS-A operations and provided valuable feedback in several interactive settings. D10 controllers noted that although ATC procedure changes during the CAS-A operational evaluation had reduced the controller benefits of CAS-A operations at D10, controllers saw benefits during certain conditions and wanted to continue using CAS-A operations. D10 controllers also said they believed CAS-A operations would provide benefits for other airports. It was also noted that D10 controllers don't extensively use pilot-applied visual separation in arrival operations. D10 controllers reported challenges with the limited number of equipped aircraft and remembering which aircraft were equipped. D10 controllers said capability indicators on their Standard Terminal Automation Replacement System (STARS) displays and more equipped aircraft are necessary before a larger number of operations can be expected.

7 Acronyms

AAL	American Airlines
AAR	Airport Acceptance Rate
AC	Advisory Circular
ACSS	Aviation Communication & Surveillance Systems
ADS-B	Automatic Dependent Surveillance - Broadcast
AGD	ADS-B Guidance Display
AIRS	ADS-B In Retrofit Spacing
APA	Airlines Pilots Association
ARC	Aviation Rulemaking Committee
ASA	Aircraft Surveillance Application
ASPM	Aviation System Performance Metrics
ASQP	Airline Service Quality Performance
ATC	Air Traffic Control
ATO	Air Traffic Organization
CAPP	CDTI Assisted Pilot Procedure
CAS	CDTI Assisted Separation
CAS-A	CAS on Approach
CAVS	CDTI Assisted Visual Separation
CBT	Computer-Based Training
CCI	Crew Check In
CDTI	Cockpit Display of Traffic Information
ceo	Current Engine Option
CLT	Charlotte Douglas International Airport
CS	Call Sign
D10	Dallas-Fort Worth TRACON
DFW	Dallas-Fort Worth International Airport
DL	Distance Learning
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
HDG	Heading
HH	Hours
I-IM	Initial-Interval Management
IAD	Inter-Arrival Distance
IAT	Inter-Arrival Time
IATA	International Air Transport Association
IC	Instrument approach CAS-A
ICAO	International Civil Aviation Organization
ID	Identification
IFP	Instrument Flight Procedures
IMC	Instrument Meteorological Conditions
IOAA	IFP, Operations, and Airspace Analytics
kt	Knot
LAX	Los Angeles International Airport
MCDU	Multi-Function Control and Display Unit

MCO	Orlando International Airport
MIA	Miami International Airport
min	Minute
MM	Minutes
MMC	Marginal Meteorological Conditions
MOPS	Minimum Operational Performance Standards
MSAW	Minimum Safe Altitude Warning
MSL	Mean Sea Level
MVA	Minimum Vectoring Altitude
N/A	Non-Applicable
NAS	National Airspace System
NATCA	National Air Traffic Controllers Association
ND	Navigation Display
neo	New Engine Option
NM	Nautical Mile
OOOI	Out-Off-On-In
PDARS	Performance Data Analysis and Reporting System
PF	Pilot Flying
PHL	Philadelphia International Airport
PHX	Phoenix Sky Harbor International Airport
PM	Pilot Monitoring
RA	Resolution Advisory
RTCA	RTCA
SEA	Seattle-Tacoma International Airport
SM	Statute Mile
SME	Subject Matter Expert
SMS	Safety Management System
SRM	Safety Risk Management
SRMD	Safety Risk Management Document
SRMP	Safety Risk Management Panel
STARS	Standard Terminal Automation Replacement System
TA	Traffic Advisory
TBO	Trajectory Based Operations
TCAS	Traffic alert and Collision Avoidance System
TRACON	Terminal Radar Approach Control
TRK	Track
TSO	Technical Standard Order
TTF	Traffic-To-Follow
UTC	Coordinated Universal Time
VC	Visual approach CAS-A
VMC	Visual Meteorological Conditions
VSA	Enhanced Visual Separation on Approach

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9 Appendices

9.1 CAS-A Observation Form

Date: _______________________ **Local** / **UTC** Observer:___________________

CAS trail call sign	**ID AAL**_______________	
Lead call sign and type aircraft	**ID**_______________	**Type**_________________
ATC *designate* instruction location?	**Beyond traffic pattern** / **Downwind** / **Base** / **Dogleg** / **Final**	
New designate comm used?	**Yes** / **No**	& Report request? **Yes** / **No**
Modified Lead CS?	**Yes** / **No**	**Detail**_____________________________
ATC offer designation?	**Yes** / **No**	
Pilot unable/reject *designation*?	**Yes** / **No** / **No, but no report back** / **No report until ATC ?**	
Who gave the *designate* instruction?	**Feeder** / **Final**	**Position:**____
Pilot reply to designate delayed?	**Yes** / **No**	
Designation comm issue?	**Yes** / **No** →	(see back)
Who gave the *follow traffic*?	**Feeder** / **Final**	**Position:**____ **Runway**____
When was the *follow traffic* issued?	**With** / **After** (the approach clearance)	
Pilot unable/reject/ignore *follow traffic*?	**Yes** / **No**	
Did ATC assign a speed on final?	**Yes** / **No**	**What speed?**_________
What was the initial spacing on final?	________________ **NM** between aircraft	
Did ATC assign a **second** speed?	**Yes** / **No**	**What speed?**_________
Did ATC mention lead spacing/speed?	**Yes** / **No**	
Was CAS canceled (after *follow traffic*)?	**Yes** / **No**	**Initiator**: **Pilot** / **ATC**
What type of approach?	**Visual** / **Instrument**	
What was the final spacing?	________________ **NM** when lead over threshold	
Call sign confusion?	**Yes** / **No**	**Detail**________________
Were there other unexpected events?	**Yes** / **No** (explain below)	
What were the weather conditions?	**Ceiling** _________ **Visibility** ______ **Other**_______	
Type of operation (hazy vis, trips)?		
Summary	**Completed no issue** / **Completed issue** / **Completed ukn** / **Incomplete at desig** / **Incomplete aft desig**	

Notes:

		Inc	Notes
Readback			
"Wilco," "roger," etc			
Ownship	**Company**		
	Number		
"Expect to follow/desig"			
Lead	**Company**		
	Number		
"Report designated"			
Other:			
Issue			No readback / Req to repeat lead CS / Wrong lead CS used / Other
Report			
Ownship	**Company**		
	Number		
"has designated"			
Lead	**Company**		
	Number		
Other:			
Issue			No report / Delay until ATC query / Wrong lead CS used / Other
ATC Issue			No wrong CS correction / Other

9.2 APA Pilot Feedback Form

Specific CAS Operation Questions

1) What was your general experience with this specific CAS-A operation? **Positive / Neutral / Negative**

 ____

2) Were there any specific challenges for this CAS-A operation? **Yes / No**

 ____

3) Was the CAS phraseology explicit and understandable? **Yes / No**

 ____

4) Do you have any feedback related to the avionics interface (i.e., MCDU, ND, or AGD) for CAS CAS-A operations? **Yes / No**

 ____

5) Is there additional information that would be useful in the training material? **Yes / No**

 ____

Broader CDTI Questions

6) Have you used CAVS to gain a comfort level with the equipage? **Yes / No**

 ____

7) Do you behave differently when using CDTI to follow traffic then you do when conducting visual separation without the equipment? **Yes / No**

 ____

8) Has the CAS-A equipment helped when following traffic? **Yes / No** How?

 ____

9) Do you believe the CDTI is an enhancement to safety? **Yes / No**

 ____

10) Do you find the traffic range advisory useful? **Yes / No**

 ____

9.3 D10 Controller Feedback Form

What was your overall impression of CAS-A? (circle one)

Positive	**Neutral**	**Negative**

CAS-A was: (*Circle one or two*)	Useful	Helpful	Neither	Unknown

Were there any **controller** issues? (e.g., procedures or phraseology) (*circle one*)	Yes	No

Were there any **AAL pilot** issues? (*circle one*)	Yes	No
Were there any other airline **pilot** issues with callsign use? (*circle one*)	Yes	No

Additional Feedback

Position Name	**CAS-A status at position (circle one or more)**	**Date & Time (UTC)**	**Trail Aircraft ID**	**Lead Aircraft ID**
AR1 AR2 AR3 AR5 AR6 FE FW	**Pilot-Rejected CAS Issued Canceled**			

Comments (provide any additional thoughts, particularly if you have ideas on how it was useful/helpful or if there was an issue): ______________________________________

____

____

____

____

____

9.4 AIRS A321 Workaround SRM Document

See https://www.faa.gov/sites/faa.gov/files/A321%20Workaround%20SRM%20Document.pdf

9.5 AIRS CAS-A Operational Evaluation at D10 SRM Document

Surveillance and Broadcast Services (SBS) Group

Safety Risk Management (SRM) Document for Automatic Dependent Surveillance-Broadcast (ADS-B) In Retrofit Spacing (AIRS) Cockpit Display of Traffic Information (CDTI) Assisted Separation on Approach (CAS-A) Operational Evaluation at Dallas/Fort Worth TRACON (D10)

SBS-198, Rev. 01
SMTS20220202000049

MARCH 31, 2022

Approved by:

PAUL DOUGLAS ARBUCKLE Digitally signed by PAUL DOUGLAS ARBUCKLE Date: 2022.04.12 10:04:46 -04'00'

Doug Arbuckle, Chief Scientist & International Lead Surveillance Services Directorate, AJM-4 — Date

Federal Aviation Administration
600 Independence Avenue, SW
Washington, DC 20591

Revision History for
Safety Risk Management (SRM) Document
For AIRS CAS on Approach Operational Evaluation at Dallas/Fort Worth TRACON (D10)
SBS-198, Revision 01

Revision Number	Description	Document Date
01	Initial Baseline	March 31, 2022

Title: Safety Risk Management (SRM) Document for AIRS CAS on Approach Operational Evaluation at Dallas/Fort Worth TRACON (D10)

Initiator: Doug Arbuckle, Chief Scientist & International Lead
Initiator's Organization: Surveillance Services Directorate, AJM-4
Initiator's Phone Number: (757) 846-4225

Submission Date: March 31, 2022
SRMD Revision Number: SBS-198, Revision 01
SRMD Revision Date: March 31, 2022

SRMD Signatures:

Approved by: ______ Digitally signed by MARK W STEINBICKER Date: 2022.05.05 08:56:27 -04'00' Date: May 5, 2022
Robert M. Ruiz
Director, Office of Safety Standards, AFS-1

Title: Safety Risk Management (SRM) Document for AIRS CAS on Approach Operational Evaluation at Dallas/Fort Worth TRACON (D10)

Initiator: Doug Arbuckle, Chief Scientist & International Lead
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Initiator's Phone Number: (757) 846-4225

Submission Date: March 31, 2022
SRMD Revision Number: SBS-198, Revision 01
SRMD Revision Date: March 31, 2022

SRMD Signatures:

Digitally signed by EVAN W SETZER
Date: 2022.04.22 20:21:52 -04'00'
Adobe Acrobat version: 2021.011.20039

Reviewed by: ______________________________ Date: __________
Evan W. Setzer
Group Manager, Surveillance & Broadcast Services, AJM-42

Title: Safety Risk Management (SRM) Document for AIRS CAS on Approach Operational Evaluation at Dallas/Fort Worth TRACON (D10)

Initiator: Doug Arbuckle, Chief Scientist & International Lead
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Initiator's Phone Number: (757) 846-4225

Submission Date: March 31, 2022
SRMD Revision Number: SBS-198, Revision 01
SRMD Revision Date: March 31, 2022

SRMD Signatures:

Risk Acceptance of Air Traffic Controller Phraseology and Responsibilities by: JEFFREY S SZCZYGIELSKI Digitally signed by JEFFREY S SZCZYGIELSKI Date: 2022.12.21 12:44:36 -05'00' ______________________ Date: ____________

Jeffrey Szczygielski
Director, Operational Policy and Implementation, AJT-2

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Title: Safety Risk Management (SRM) Document for AIRS CAS on Approach Operational Evaluation at Dallas/Fort Worth TRACON (D10)

Initiator: Doug Arbuckle, Chief Scientist & International Lead
Initiator's Organization: Surveillance Services Directorate, AJM-4
Initiator's Phone Number: (757) 846-4225

Submission Date: March 31, 2022
SRMD Revision Number: SBS-198, Revision 01
SRMD Revision Date: March 31, 2022

SRMD Signatures:

Risk Acceptance of Flight Crew Procedures and Responsibilities by: Digitally signed by MARK W STEINBICKER Date: 2022.12.14 16:06:05 -05'00' Date: December 14, 2022
Robert M. Ruiz
Director, Office of Safety Standards, AFS-1

AJM-221209-001-AVS-001

Executive Summary

The Federal Aviation Administration's (FAA) Surveillance and Broadcast Services (SBS) Group is interested in promoting the adoption of Automatic Dependent Surveillance-Broadcast (ADS-B) In applications that can increase the safety and efficiency of the National Airspace System (NAS). To that end, the FAA, American Airlines, Inc. (AAL), and Aviation Communication & Surveillance Systems, LLC (ACSS) entered into an agreement in September 2017, to support the evaluation of ADS-B In operations by equipping the entire AAL Airbus A321 (A321) fleet with certified ACSS SafeRoute+™ avionics. The ADS-B In operations being evaluated are Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS), CDTI Assisted Separation on Approach (CAS-A), and Initial-Interval Management (I-IM). The primary objective of this project is to promote the early adoption of ADS-B In applications by fielding a cost-effective retrofit solution.

ACSS developed a retrofit architecture using existing flight deck displays, supplemented with a graphical ADS-B Guidance Display (AGD). The architecture includes the display of ADS-B traffic along with Traffic Collision Avoidance System (TCAS) traffic on the navigation display, flight crew data entry via the Multi-Purpose Control Display Unit (MCDU), and display of application-specific information on the AGD. For the ACSS SafeRoute+™ implementation, the combination of AGD, TCAS traffic display, and MCDU are collectively referred to as the CDTI. This architecture is more economically viable than previous retrofit architectures and has the potential to enable early adoption of ADS-B In applications without waiting for forward fit implementations.

This Safety Risk Management (SRM) document addresses the Operational Evaluation (OpEval) of CAS-A to the same arrival runways at Dallas/Fort Worth International Airport (DFW). The scope includes the coordinated use of CAS-A by the approach controllers in Dallas/Fort Worth Terminal Radar Approach Control (TRACON) (D10) and American Airlines pilots operating ACSS-equipped A321 aircraft in-trail of an ADS-B Out aircraft arriving to the same runway. The Safety Risk Management Panel (SRMP) reviewed the Operational Description as part of the hazard assessment and provided input to assist the trial site in finalizing their Standard Operating Procedures (SOPs) and phraseology.

The change to phraseology is for the sole purpose of the facility (D10) and pilots participating in the trial, for the duration of the trial, and whose use is to be discontinued at the termination of the trial. Air Traffic Services (AJT 2&3) accepts the risk associated with this temporary change in phraseology. Air Traffic's separation responsibility will not change or be altered with this trial.

Summary of Findings

The SRMP convened virtually on January 11 and 12, 2022, to identify and assess the hazards associated with the proposed CAS on Approach OpEval in D10's airspace. The panel was comprised of stakeholders representing the FAA's Flight Standards Service (AFS), FAA Air Traffic Services (AJT), FAA Mission Support Service (AJV), D10 air traffic control (ATC), National Air Traffic Controllers Association (NATCA), AAL management and flight operations, the Allied Pilots Association (APA), and subject matter experts (SMEs) in air traffic operations, flight operations, and safety. The assessment was conducted in accordance with the FAA Air Traffic Organization (ATO) Safety Management System (SMS) manual dated April 2019.

The SRMP identified one new hazard associated with designating the incorrect Traffic-To-Follow (TTF). There were four effects from the hazard, two of which addressed the aircraft getting too close to another aircraft (likely requiring a go-around), one addressed increased communication, and the fourth addressed loss of situational awareness. The SRMP identified several controls in place that minimized the severity of the impact leading to severity ratings of 5 (Minimal) and 4

(Minor). The panel also noted the duration of the OpEval is one year, with operations solely at D10, and with a limited number of equipped aircraft. The panel agreed that the likelihoods of these effects occurring were C (Remote) and D (Extremely Remote). All four effects were found to have Low risk (see Section 4.6).

Table ES-1 below summarizes the identified hazard.

Table ES-1: CAS on Approach OpEval Hazard Summary

No.	Hazard Title	Initial Risk	Predicted Residual Risk
CAS-1	**Designate the Wrong Traffic-To-Follow (TTF)** *-There were 4 separate effects*	5D (Low) 5C (Low) 5C (Low) 4D (Low)	5D (Low) 5C (Low) 5C (Low) 4D (Low)

Figure ES-1 is an illustration of the hazard's Initial and Predicted Residual Risk based on the SRMP's results.

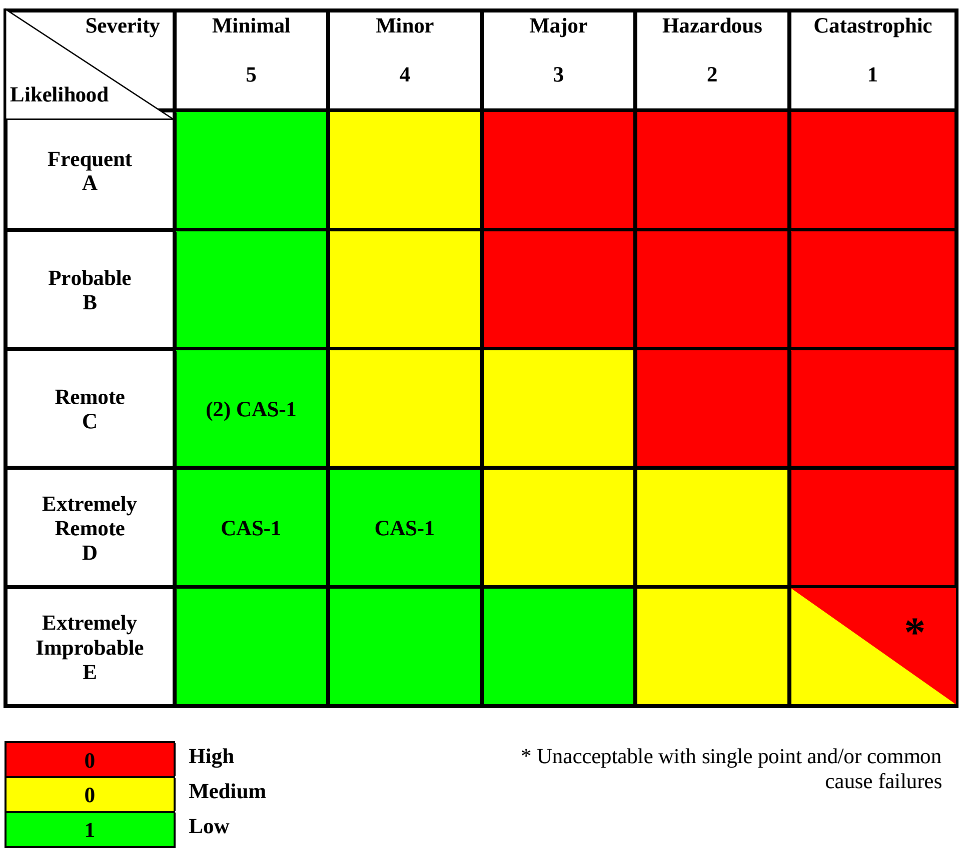

Figure ES-1: Initial and Predicted Residual Risk Matrix

No new safety requirements were recommended by this SRMP. Information about hazard monitoring is included in Section 4.9 of this document.

Conclusion

The SRMP unanimously identified one new, low risk hazard and recommended no safety requirements. The OpEval has a duration of one year within the D10 TRACON airspace for American Airlines equipped A321 aircraft on approach into DFW. The CAS-A team identified data sources and parameters in the monitoring plan of this SRM document to evaluate the performance and operational efficiencies of CAS on Approach at D10. The data to be collected should provide quantitative data which is expected to support both the NAS-wide expansion of CAS on Approach as well as other ADS-B In applications in the ADS-B In Retrofit Spacing (AIRS) portfolio.

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1 Introduction

The Federal Aviation Administration's (FAA) Surveillance and Broadcast Services (SBS) Group is interested in promoting the adoption of Automatic Dependent Surveillance-Broadcast (ADS-B) In applications that can increase the safety and efficiency of the National Airspace System (NAS). To that end, the FAA, American Airlines, Inc. (AAL), and Aviation Communication & Surveillance Systems, LLC (ACSS) entered into an agreement in September 2017 to support the evaluation of ADS-B In operations by equipping the entire AAL Airbus A321 (A321) fleet with certified ACSS SafeRoute+™ avionics. The ADS-B In operations being evaluated are Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS), CDTI Assisted Separation on Approach (CAS-A), and Initial-Interval Management (I-IM). The primary objective of this project is to promote the early adoption of ADS-B In applications by fielding a cost-effective retrofit solution.

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This Safety Risk Management (SRM) document addresses the operational evaluation (OpEval) of CAS-A to the same arrival runways at Dallas/Fort Worth International Airport (DFW). The scope includes the coordinated use of CAS-A by the approach controllers in Dallas/Fort Worth Terminal Radar Approach Control (TRACON) (D10) and American Airlines pilots operating ACSS-equipped A321 aircraft in-trail of an ADS-B Out aircraft arriving to the same runway. The Safety Risk Management Panel (SRMP) reviewed the Operational Description as part of the hazard assessment and provided input to assist the trial site in finalizing their Standard Operating Procedures (SOPs) and phraseology.

2 Current System

Currently, an increase in landing capacity and/or increase in the number of movements can be achieved when air traffic control (ATC) can instruct flight crews to use pilot-applied visual separation during approach. This most frequently occurs during visual approach operations. Arrival rates at airports in the NAS are significantly higher when controllers can rely on visual separation provided by the flight crew. Two factors contribute to this:

1. When the controllers know that flight crews can conduct pilot-applied visual separation, they are able to reduce spacing over the threshold, delivering aircraft at appropriately closer distances on long final to take advantage of this tighter eventual spacing. After this is set-up by the controller, flight crews perform the approach at a safe landing interval.
2. When flight crews can conduct visual separation, controllers deliver spacings over the runway threshold that are consistently closer than they are able to achieve when the controller must apply standard "radar" separation.

During visual approach operations, the primary influence is runway separation where only one aircraft may occupy the runway at a time. This separation, as defined in FAA Joint Order (JO) 7110.65 Para. 3-10-3, Same Runway Separation, is typically between 2 and 2 ½ nautical miles (NM). During instrument approach operations, the primary influence is radar separation, as defined in FAA JO 7110.65 Para. 5-5-4, Minima. Since approach controllers are responsible for separation to the runway threshold, they apply a buffer in excess of separation minima. This results in gaps between successive arrivals of 3 to 4 NM, due to the uncertainty of arrival aircraft final approach speed.

3 Description of Change

As stated in the Operational Description *(ADS-B In Retrofit Spacing (AIRS) CDTI Assisted Separation (CAS) Single Runway Operational Description, Version 4.0, February 2, 2022)* in Appendix D of this document, the objective of CAS on Approach is to maintain visual-like separation safely and more efficiently from Traffic-To-Follow (TTF) via the CDTI during approach procedures. The CAS-A operation is expected to capture some of the runway capacity benefits of visual separation operations during weather conditions that do not support visual approaches with pilot-applied visual separation and during visual approach conditions when identification of the TTF out the window (OTW) may be delayed or impossible until short final.

CAS-A builds on the existing CAVS operation, as described in Advisory Circular 90-114B (Automatic Dependent Surveillance-Broadcast Operations), and the same flight deck tools are used for both CAS-A and CAVS (see Figure 3-1). CAVS allows flight crews to use information on the CDTI as an alternative to the requirement for continuous visual observation of TTF during visual meteorological conditions (VMC). With CAVS, once the flight crew has visually acquired and accepted a visual approach clearance behind the TTF, the pilot can use the TTF information on the CDTI as a means for maintaining separation during a visual approach when OTW visual contact cannot be maintained (i.e., due to haze, background lights at night, or glaring sun). The CAVS operation is transparent to the controller and is not controller-initiated.

Figure 3-1: Sample ADS-B Guidance Display During CAS-A Operation

The CAS-A operation is initiated by the controller, who provides the Flight Identification (ID) of the Traffic-To-Follow and then an approach clearance with instructions to follow the designated traffic. The flight crew identifies the TTF on the CDTI based on the Flight ID provided by the controller. OTW visual acquisition is not required. After traffic identification and designation, the flight crew uses the TTF information available on the CDTI to conduct pilot-applied separation operations.

CAS-A may only be used when both aircraft are approaching the same runway. CAS-A does not modify Visual Flight Rules (VFR) or Instrument Flights Rules (IFR). CAS-A may be conducted when the airport of intended landing has a reported ceiling of 1000 feet or greater and visibility of 3 statute miles (SM) or greater. The aircraft conducting a CAS-A operation may enter Instrument Meteorological Conditions (IMC) conditions, except when conducting a visual approach. It allows the flight crew to use the CDTI alone to maintain separation from the TTF. Per Operations Specification, Paragraph A355, ADS-B In Operations, American Airlines, Inc. is authorized use of Cockpit Display of Traffic Information (CDTI) equipment to support CDTI Assisted Separation (CAS) operations per FAA guidance. Separation responsibilities after the assignment and acknowledgement of the traffic to follow using the CDTI remains with the pilot as it does today for standard out the window visual separation. CAS-A operations do not change any requirements associated with wake minima or avoidance of wake turbulence. CAS-A does not have any effect on controller responsibilities for separation before the issuance of the CAS-A instruction and after the conclusion or termination of the CAS-A operation. CAS-A does not have any effect on controller responsibilities for runway separation and separation for those aircraft not part of the CAS-A trial. Air traffic controllers are still expected to employ the rules they currently use for the control and separation of air traffic, to include any inter/intra facility coordination and communications.

Table 3-1: Operational Differences

	Visual Separation Operation	CAVS Operation	CAS-A Operation
Weather Minimums	1000 ft. Ceiling/ 3 SM Visibility	1000 ft. Ceiling/ 3 SM Visibility	1000 ft. Ceiling/ 3 SM Visibility
Cloud Clearance Required	Clear of clouds	Clear of Clouds	• Clear of clouds if CAS-A is in conjunction with a visual approach clearance • No restriction if CAS-A is in conjunction with an instrument approach clearance • Note: Airport of intended landing needs to be VMC (Weather Minimums)
Separation Minimums	None in the air. Runway separation rules still apply.	None in the air. Runway separation rules still apply.	None in the air. Runway separation rules still apply.
Separation Responsibility	Flight Crew	Flight Crew	Flight Crew
Phraseology – ATC & Pilots	Not applicable	Same as Visual	New – Use of Flight ID for TTF
Aircraft Equipment Required	None	CAVS TSO-C195b (or later) certified avionics	CAVS TSO-C195b (or later) certified avionics
Pilot Training Required	Basic Pilot Training	Basic Pilot Training Avionics-Specific Training CAVS-Specific Training	Basic Pilot Training Avionics-Specific Training CAS-A Specific Training
ATC Training Required	Basic ATC Training	Basic ATC Training	CAS-A Specific Training

	Visual Separation Operation	CAVS Operation	CAS-A Operation
How Approach is Initiated	No change in approach initiation	No change in approach initiation	No change in approach initiation
Transfer of Separation Responsibility Initiation	Instruction from ATC to “Maintain Visual Separation” after Visual (OTW) Acquisition of TTF (may also be "Follow the preceding aircraft to the field visually”)	Instruction from ATC to “Maintain Visual Separation” after Visual (OTW) Acquisition of TTF (may also be "Follow the preceding aircraft to the field visually”)	Instruction from ATC to “Follow Designated Traffic” after Identification and Designation of TTF in avionics
Pilot Identification of Traffic-To-Follow	Visual (OTW) Acquisition	Visual (OTW) Acquisition with assistance from CDTI	CDTI Only based on controller-provided Flight ID
ATC Communication of Traffic-To-Follow	Distance/Bearing, Aircraft Type, and Carrier	Distance/Bearing, Aircraft Type, and Carrier	Flight ID (Call Sign)

4 Hazard Identification and Risk Determination

4.1 Preliminary Safety Analysis Meeting

A working group meeting was held December 14, 2021, to identify and discuss areas of concern for the proposed OpEval. The working group took the opportunity to begin a preliminary hazard list (PHL) and listed potential concerns that weren't necessarily hazards to be presented during the SRM panel January 11 and 12, 2022. The session allowed stakeholders to express their concerns and identify areas requiring more supporting and/or historical background so the panel could adequately assess the issues when they met in January. The following is the list created at the December 2021 meeting:

(1) Call Sign Mismatch (CSMM)[1] related to unfamiliar use of the traffic flight identifier
(2) Similar call signs between aircraft, resulting in erroneous flight identification
(3) Selecting the wrong traffic
  - On a parallel runway
  - Or following to wrong runway
(4) Failure to respond to alerts, management of AGD information
  - Surveillance Range alert[2]
  - Expectation bias
    - Comfort levels for flight crew
  - Flight crew slowing too much/reducing speed excessively
(5) Automated Terminal Proximity Alert (ATPA) alert is off on approach with VS (visual separation) in datablock – will still see distance
(6) Aircraft proximity too close to other aircraft
(7) New Phraseology for both ATC and Flight crew, managed in training
  - Notice to Air Mission (NOTAM) for all aircraft flying into DFW
  - Use of third-party flight ID
    - Increased communications for ATC
    - Questions and confusion from other aircraft hearing their Flight ID
(8) Changes for DFW Tower, via Letter of Agreement (LOA)
  - Will see VS in datablock at times not normally seen

[1] Call Sign Mismatch (CSMM) occurs when the ADS-B Out broadcasted flight ID does not exactly match the call sign in the filed flight plan. The flight ID broadcast from ADS-B is the source of the call sign attached to the controller's data block.

[2] TRAFFIC RANGE appears on the AGD when the designated traffic horizontal range becomes closer than the range alert threshold on the MCDU Traffic Information page.

4.2 Operational Evaluation Scope

The SRMP was presented with an extensive description of the proposed operation, which is included in Appendix D. ACSS representatives described the avionics and cockpit layout, D10 representatives provided details about the approach controller operations, and AAL representatives provided information on flight deck procedures to be used. From those descriptions, the panel reviewed and identified the following elements to assist in focusing the scope of the OpEval. Table 4-1 outlines the 5M elements involved in describing the proposed change.

Table 4-1: 5M Elements

<table>
<tr><td colspan="2"><u>Mission</u>
To maintain visual-like separation safely and more efficiently from TTF via the CDTI during approach procedures</td></tr>
<tr><td><u>(hu)Man</u>
Pilots
ATC personnel (Traffic Management Unit (TMU), Operational)</td><td><u>Machine</u>
D10 Surveillance and Automation Platforms
ADS-B, both Out and In
ACSS CAVS Avionics
Navigation Functions for Arrival and Runway
Communications medium between ATC and the flight deck</td></tr>
<tr><td><u>Management</u>
FAA Order 7110.65
-Paragraph 5.5.2, Target Separation
-Paragraph 5.5.4, Minima
-Paragraph 5.9.3, Vectors Across Final Approach Course
-Paragraph 7.2.1, Visual Separation
-Paragraph 7.4.3, Clearance for Visual Approach
-Paragraph 7.4.4, Approaches to Multiple Runways
Federal Aviation Regulations (FAR) Part 121.544, Pilot Monitoring
Airline Ops Specs
Operational Agreements (LOAs, Operational Procedures with unions) – N D10 7110.426
American Airlines Training Procedures
D10 Training Procedures
NOTAM to alert other carriers of the operation</td><td><u>Media (environment)</u>
Airline Training Facility
Flight deck
D10 TRACON
D10 Airspace</td></tr>
</table>

4.3 Assumptions

The assumptions were obtained from the Operational Description and further developed by the SRMP.

4.3.1 D10 and DFW Assumptions

- D10 controllers will be trained for the operation prior to the start of CAS-A operations
- No changes to ATC automation
- Local controllers will be informed on the use of CAS-A operations
- ATC will use the scratch pad entry in Standard Terminal Automation Replacement System (STARS) for the CAS-A operation, as they currently do for visual operations
- Local controller responsibilities do not change
- A NOTAM or Letter to Airmen (LTA) will be issued for awareness to all aircraft flying into DFW
- No change in current operation of ATPA
- Controllers will use the Flight ID of the TTF when identifying that aircraft
- As with current day pilot-applied visual separation operations, CAS-A aircraft is not authorized to follow a Super category aircraft
- CAS-A does not change any pilot and controller procedures related to wake vortex avoidance/limitations or runway occupancy time
- Controllers are responsible for the separation of aircraft not participating in the CAS-A trial, as they are today.
- Controllers are responsible for separation of CAS-A aircraft from all other aircraft before the issuance of the CAS-A instruction and after the conclusion or termination of the CAS-A operation. During the CAS-A operation, Air Traffic is responsible for separating the CAS-A aircraft from all aircraft except for the designated aircraft as is done with pilot-applied visual separation today. This separation is to include runway separation, as well as any resulting compression on final for those aircraft not participating or assigned the CAS-A operation.
- Air Traffic will continue to use the same communication and control procedures they currently employ in the control of air traffic outside of the changes to phraseology for the purposes of this trial.

4.3.2 Flight Crew Assumptions

- Only American Airlines A321 aircraft equipped with avionics system meeting the requirements for CAVS defined in TSO-C195b or later will participate
- All AAL A321 flight crews will be trained prior to the start of CAS-A operations
- TTF Flight ID will be cross-checked by a second flight crew member
- As with current day operations, approach guidance (e.g., instrument landing system (ILS), localizer (LOC), area navigation (RNAV)) will be displayed whether on visual or instrument approach for the assigned runway
- CAS-A can be used when an equipped aircraft is in IMC or VMC, on an instrument or a visual approach at DFW
- CAS-A is applicable between the CAS-A aircraft and a single TTF approaching the same runway

- Separation responsibilities after the assignment and acknowledgement of the TTF using the CDTI remains with the pilot as it does today for standard OTW pilot-applied visual separation.

4.4 Hazard Identification

After the panel discussed the technical and operational parameters to scope the assessment, they revisited the list of concerns (see Section 4.1) identified at the preliminary safety assessment meeting in December 2021. Before they engaged in evaluating the items on the list, they identified additional items for the list:

(9) Increase in heads-down time

(10) Designating the incorrect TTF

(11) Increase in blunders due to using CAS-A

(12) Confusion over separation responsibility when the CAS-A instruction is cancelled

(13) Impact on CAS-A aircraft following sidestep of TTF to parallel runway

4.5 Hazard Model Definitions

After identifying the list of potential issues, the panel reviewed the PHL to determine if each of the identified concerns was a hazard associated with the change, a cause or effect of the hazard, or if the hazard already exists in the NAS. This SRM document has been prepared in accordance with FAA Air Traffic Organization (ATO) Safety Management System (SMS) manual, April 2019. The severity and likelihood tables referenced by the panel are in Appendix B.

As the panel discussed the identified hazard, the severity of each effect was determined using the severity tables as guidance. The likelihoods for the hazard and its effects were determined based on qualitative estimates by the experienced stakeholders and SMEs on the SRMP. The risk associated with each effect was based on integrating the two factors: severity of consequence and likelihood of occurrence.

4.6 Identified Hazard

The CAS on Approach OpEval SRMP identified one new hazard associated with the wrong TTF selected in the avionics.

Hazard CAS-1 – Designate the Wrong Traffic-To-Follow

Designating the incorrect TTF was determined to be credible with several causes. The SRMP identified similar call signs leading to either ATC providing the wrong flight ID, or the flight crew hearing an incorrect flight ID, as causes for this hazard. Although the incorrect aircraft flight ID may not be a choice on the CDTI, it may lead the flight crew to selecting the wrong TTF. CSMM could lead the approach controller to provide an aircraft flight ID for traffic that the flight crew cannot find on the CDTI because that aircraft is broadcasting the incorrect aircraft flight ID.

Additionally, the wrong TTF may be selected by a pilot during input into the CDTI, leading to the CDTI providing information to the flight crew that does not represent accurate range to the intended TTF and differential ground speed (the difference of the magnitudes of the ground speed between the TTF and the CAS-A aircraft) behind the intended TTF.

Therefore, the worst credible effect was determined to be the CAS-A aircraft getting too close to another aircraft, either longitudinally or laterally. The more likely scenario was getting too close to an aircraft in line to the same runway by closing on them too quickly. Alternatively, the CAS-A aircraft could slow too much, resulting in reduced separation with the aircraft behind. Given all potential causes of this hazard, existing controls were identified resulting in severity ratings of 5 (Minimal) and 4 (Minor). To reduce the likelihood of the hazard occurring, the procedures require the flight crew to cross-verify the aircraft ID with each other as it is entered into the MCDU, as well as reading back the flight ID to ATC after designating traffic.

The panel determined the likelihoods based on the SMS Qualitative Table (see Appendix B). With the panel members' extensive experience both within the TRACON and on the flight deck operating into DFW, the panel concurred that the Likelihoods would be C (Remote) and D (Extremely Remote).

The four separate effects of the hazard are as follows:

- *CAS-A aircraft and TTF are too close to apply runway separation*
  The result of this effect would be for ATC to issue a go-around. This occurs today and is a practiced operation for the flight crew. The panel considered this to be 5 (Minimal) with a D (Extremely Remote) likelihood due to the experience of the controllers to set up the appropriate spacing between arrivals. Thus, it results in a 5D (Low) risk.

- *Increased communication/Increased workload*
  If the hazard is realized due to CSMM or the incorrect flight ID provided, the panel felt there would be a back-and-forth on the radio to resolve the issue and correct the situation. Therefore, the increase in communication and workload were effects that may occur and is part of normal operations. The panel considered this to be 5 (Minimal) with a C (Remote) likelihood, resulting in a 5C (Low) risk.

- *Loss of Situational Awareness (SA) on flight deck*
  With the incorrect TTF displayed on the CDTI, the system would be providing information about an aircraft other than the actual TTF, which may cause confusion on the flight deck. The panel took into consideration all the controls in place to manage the procedure and prevent the effect from being realized and agreed on a severity of 5 (Minimal). Considering the scope of the OpEval and that it is a new operation, they concurred with a C (Remote) likelihood, resulting in a 5C (Low) risk.

- *Loss of separation with another aircraft*
  This effect pertained to the potential for the flight crew to slow down extensively based on the incorrect information being provided on their CDTI. It was considered that the hazard condition would be a trailing aircraft closing in on the CAS-A aircraft from behind. The panel conservatively determined this to be slightly higher severity and decided it was 4 (Minor). However, with the separation being conditioned by the approach controllers and the limited exposure time within the arrival corridor for the effect to be realized, they determined it to have a D (Extremely Remote) likelihood, resulting in a 4D (Low) risk.

Concerns originally identified in the PHL were classified as causes, effects, and the hazard as noted below. (*The number in parenthesis refers to the identified concern in the PHL list, Sections 4.1 and 4.4*):

- *(1) Call-sign Mismatch (CSMM) at D10 regarding novel use of target identifier* – **Cause for CAS-1 Hazard**
- *(2) Erroneous ID of TTF aircraft* – **Cause for CAS-1 Hazard**

- *(3) Selecting wrong TTF* – **Cause for CAS-1 Hazard**
- *(6) Aircraft proximity too close to other aircraft* – **Effect for CAS-1 Hazard**
- *(10) Designate the incorrect aircraft* – **Hazard CAS-1**

Additional information regarding the panel's findings can be found in the Hazard Analysis Worksheet (HAW), included as Appendix C. Table 4-2 summarizes the identified hazard.

Table 4-2: CAS-A Hazard Summary

No.	Hazard Title	Initial Risk	Predicted Residual Risk
CAS-1	**Designate the Wrong Traffic-To-Follow (TTF)** *-there were 4 separate effects*	5D (Low) 5C (Low) 5C (Low) 4D (Low)	5D (Low) 5C (Low) 5C (Low) 4D (Low)

4.7 Hazard Risk Matrix

The hazard risk is determined from the Risk Assessment Matrix shown in Figure 4-1. Severity is shown in the top row and likelihood is in the left column. Severities range from minimal to catastrophic, while likelihoods range from frequent to extremely improbable. The four separate effects from Hazard CAS-1 are identified within the table.

Severity / Likelihood	Minimal 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
Frequent A					
Probable B					
Remote C	(2) CAS-1				
Extremely Remote D	CAS-1	CAS-1			
Extremely Improbable E					*

(red)	High
(yellow)	Medium
4 Effects	Low

* Unacceptable with single point and/or common cause failures

Figure 4-1: Risk Assessment Matrix

4.8 Additional Hazards Considered

The following issues identified in the PHL and deliberated by the panel were considered not to be unique to the proposed change nor to introduce any new hazard to the NAS. *(The number in parenthesis and the title refers to the identified issue in the PHL list, Sections 4.1 and 4.4).*

- *(4) Failure to respond to alerts, management of AGD information*

  This topic generated significant back-and-forth discussion. The stakeholders considered that a lack of familiarity with the procedure and the avionics may lead to delayed responses and a loss of situational awareness. An increased amount of heads-down time was also discussed as a cause of this. However, as the SMEs provided input, they recognized that AAL has a training plan in place that address and mitigate the concerns raised at the panel. They also recognized any new procedure has a learning curve and this is an OpEval with a defined, limited scope. Therefore, no additional hazard was being introduced.

- *(5) Automated Terminal Proximity Alert (ATPA) alert is off on approach with 'VS' in datablock*

  ATPA is an automated system that will alert the controller in the TRACON if an aircraft gets within, or is projected to infiltrate, a set distance with another aircraft. According to the proposed procedures for the OpEval, the approach controller will enter 'VS' into the datablock for the CAS-A aircraft when issuing the CAS-A instruction. This is the identical entry that is performed when a pilot-applied visual separation is provided to an aircraft. The 'VS' entry disables the alert function of the ATPA; however, the controller will still be able to see distance and closure rate to the other aircraft. The SMEs determined the 'VS' entry will now be used during different weather conditions than when it is normally done, but this does not introduce any new hazard since it is the same situation that exists for pilot-applied visual separation.

- *(7) New Phraseology for both ATC and Flight crew managed in training*

  New phraseology being introduced into the flight crew and approach controller's lexicon was discussed but not considered to be a new issue for operations. The main concern of the new phraseology was the use of another aircraft's call sign in controller-pilot communications when that aircraft was not being addressed. The approach controller is going to direct the CAS-A aircraft to follow its traffic, the TTF, and provide the TTF's call sign or flight ID, known as Third-Party Flight ID (TPFID). The CAS-A aircraft will respond to the directions by repeating back the TTF's Flight ID. Therefore, the TTF aircraft may hear its call sign used twice over the frequency, but it will have no action or response required. The panel discussed that this may cause the flight crews of the TTF aircraft to be confused and/or inquire on the frequency checking if the last instruction was intended for them.

  The panel debated this concern and worked it as a hazard of increased radio communication. Prior to this conversation occurring, the stakeholders had recognized this as a possible outcome of the OpEval and had agreed to issue a NOTAM or LTA for all aircraft flying into DFW that they may hear their call sign in a clearance to other aircraft. The panel's discussion led to a possible effect being an unacceptable workload for ATC and the flight crews. However, as the discussion continued, both the controllers and the pilot SMEs stated that such radio exchanges occur today with no negative impact on workload for either. An additional mitigation is the TPFID is not to be used prior to a clearance or instruction, only after. Therefore, although they recognized that it may occur, it is not creating a new hazard or increasing the likelihood of an existing hazard. The panel members were polled and all concurred with this assessment.

  In addition to the NOTAM being issued, AAL said they would include relevant information on this topic in their F4 notification on their dispatch releases to all AAL aircraft flying into DFW, which makes up a large portion of the arrival traffic.

- *(8) Changes for DFW Tower*

  The stakeholders discussed impacts to DFW tower controllers. The OpEval will occur within D10's airspace and when the CAS-A aircraft enters DFW's airspace, the operation should be seamless. For DFW tower, there will be no change to their operations. The tower controllers will realize traffic more tightly spaced during weather conditions that are different than what is typical for non-visual approach operations. They will also see 'VS' in the datablock at times not normally seen. Although the traffic arriving to the runways will be spaced at tighter intervals than they would normally see during 'clear' weather conditions, it was determined to be no different than the spacing and information they would have during regular visual approaches.

  D10 will coordinate with DFW Tower via a letter of agreement (LOA). DFW tower managers have been informed of the proposed OpEval and attended the first day of the SRMP.

- *(9) Increase in heads-down time*

  The panel discussed the increase in heads-down time extensively. Panel members felt the subject may lead to a loss of situational awareness for the flight crew. It was combined with issue *(4)*, "*Failure to respond to alerts, management of AGD information"*, which may have caused a delayed response to flight deck alerts. In addition to the training and awareness provided leading up to the initialization of the OpEval, the panel noted that the avionics is currently being used with the CAVS operation. CAVS is being used in the NAS today by the AAL A321 flight crews. It was also noted that the AGD that provides key information and alerts is in the forward field of view. In addition, AAL already has procedures in place for the flying pilot to input the data and the non-flying pilot to verify. Thus, the panel members concurred heads-down time would not lead to a new hazard.

- *(11) Increase in blunders due to using CAS-A*

  The possibility of an increase in the number of blunders, where aircraft drift off their final approach course infringing on the parallel approach course, was raised in the context of the flight crew having their heads down in the cockpit, focusing on the TTF. The SMEs in the panel brought up that improved navigation has reduced blunders to being only a rare occurrence. Furthermore, CAS-A does not affect the navigation of the aircraft. Lastly, AAL has a policy in place to have the localizer or other guidance up on the instruments to ensure the pilots are approaching the correct runway.

- *(12) Confusion over separation responsibility when CAS-A instruction cancelled*

  The question was raised about who has separation responsibility if the CAS-A instruction is cancelled. Discussions amongst the D10 controllers and other panel SMEs were confident this was not a new hazard because when approach clearances change today, the controllers provide direction on how the flight crew is to proceed. Further discussion suggested procedures need to be clarified in the Operational Description.

- *(13)* Sidestep to parallel runway impact on CAS-A aircraft

  The scenario was raised of the TTF aircraft sidestepping or being cleared by the tower to land on a parallel runway, as opposed to the runway they were originally approaching. The panel wanted to clarify how the CAS-A aircraft would manage that adjustment to the operation. The D10 controllers stated the operation would not be handled any differently than if the TTF had to do a go-around, in which case the CAS-A aircraft would continue on their cleared approach. Similar to the previous issue, it was suggested procedures should be updated in the Operational Description and training materials will reflect this update.

4.9 Monitoring Plan

Although no safety requirements were implemented, the Program Office is responsible for ensuring that the assumptions listed in Section 4.3 are relevant for the initialization of the proposed operational evaluation. Using input from the SRMP, the monitoring parameters in Table 4-3 provide data points to assist in assessing the effectiveness of the OpEval and ensuring the accuracy of the hazard analysis. Go-arounds are derived using surveillance data gathered from the FAA's Performance Data Analysis and Reporting System (PDARS) and/or the Instrument Flight Procedures (IFP) Operations and Airspace Analytics (IOAA) tool.

Designated aircraft and target designation start and stop times are being downloaded from AAL A321 aircraft TCAS systems by AAL maintenance. The data is processed by ACSS, provided in an archive to the FAA, and correlated with FAA data (including go-arounds). The rate of go-arounds will be determined by dividing the number of AAL A321 go-arounds by the total AAL A321 arrivals in specific time periods. If an increase in go-arounds is identified, target designation data will be used to determine if the specific go-arounds were related to the presence of multiple target designations during the arrival which may indicate incorrect target-to-follow errors.

Table 4-3: Hazard Monitoring Parameter

Hazard ID	Hazard Description	Initial Risk	Safety Req	Res. Risk	Monitoring Task	Resource	Responsible Org	Due Date/ Freq.
CAS-1	**Designate the Wrong Traffic-To-Follow (TTF)**	5D (Low) 5C (Low) 5C (Low) 4D (Low)	None	5D (Low) 5C (Low) 5C (Low) 4D (Low)	AJT/AJM to coordinate with NATCA during quarterly Article 114 and/or project team meetings that include the monitoring POCs Assess Go-Around data for the OpEval period to determine if the OpEval is causing an increase in GA's Review Performance Data points to confirm no abnormal effects from OpEval Review ATSAP reports to confirm no abnormal effects from OpEval	PDARS IFP IOAA D10 Falcon replay will be coordinated with the MOR for a GA Quarterly Check Point ATSAP	AJT/AJM Program Office Program Office Program Office	Quarterly

4.10 SRM Panel Participants

An SRMP meeting convened virtually January 11 and 12, 2022, to examine potential hazards and effects associated with the proposed operational evaluation. Attendance for each day is captured along with a column to identify those who had participated in SMS training (see Table 4-4).

Table 4-4: AIRS CAS-A D10 OpEval SRM Panel

Name	Organization	Title	Role	11-Jan	12-Jan	SMS Trained
Dave Surridge	AAL	Tech Pilot/AAL Management	SME	X		X
Jon Witten	AAL	Airbus Fleet Captain	Panel Member	X		X
Ric Babcock	APA	Safety Representative - Air Traffic Procedures	SME	X	X	X
Brian Townsend	APA	Safety Representative - Air Traffic and Procedures	Panel Member	X	X	X
Andrew Benich	AAL	Airbus Technical Pilot	SME	X		X
Rick Ridenour	ACSS	Avionics SME	SME	X	X	
Cam Morast	ACSS	PM for ACSS	SME	X	X	
Brent Luna	FAA/NATCA	SBS Article 114 National Chair	SME	X		X
Jose Sifuentes	FAA/PASS	Article 13 Representative	Panel Member			
John Murdock	FAA/NATCA	Procedures Representative	Panel Member	X	X	X
Chris Aymond	FAA/NATCA	IM Representative/Terminal	SME	X	X	
Tom Zarick	FAA/NATCA	IM Representative/En Route	SME	X	X	X
William 'Bud' Debolt	D10	Air Traffic Manager	Panel Member	X	X	X
Terry Donaldson	D10	NATCA Representative	Panel Member	X	X	X
Steve Prichard	D10	NATCA Principal Facility Representative	SME	X	X	X
Jason Moore	D10	NATCA Representative	SME	X	X	X
Doug Arbuckle	FAA/SBS	Chief Scientist and Intl. Lead/Change Proponent	Panel Member	X	X	X
Paul Von Hoene	FAA/AFS-400	Aviation Safety Inspector	Panel Member	X	X	X
Chris Morris	FAA/AFS-400	Aviation Safety Inspector	SME	X	X	X
Mark Schumacher	FAA/AJT	ATC SME	Panel Member	X	X	
Kelvin Courtney	FAA/AJT-2	ATC SME	SME	X	X	X
Dilip Satheesan	FAA/AJV-P3	ATC SME	Panel Member	X	X	X
Doug Boyson	FAA/AJV-P3	Terminal SME	SME	X	X	X
Karl Howard	FAA/CSA	SMS Specialist	Observer	X	X	X
Jeff Sparrow	FAA/SBS	ATC SME/Operational Description Author	Panel Member	X	X	X
Lars Anderson	FAA/SBS	ATC SME	Observer	X	X	X

Steve Anderson	FAA/SBS	ATC SME	SME	X	X	X
Brenda Perez	FAA/SBS	Interval Management SME	SME	X	X	X
Randy Bone	FAA/SBS	Ops SME	SME	X	X	X
Rob Bradley	FAA/SBS	SRM SME	SME	X	X	X
Christine Haissig	FAA/SBS	AIRS Safety POC	SME	X	X	X
Ken Jones	FAA/SBS	Project Lead	SME	X	X	X
Angie Harris	FAA/SBS	Co-Facilitator	Co-Facilitator	X	X	X
Jamie Kirk	FAA/SBS	Facilitator	Co-Facilitator	X	X	X
Kevin Sturgill	FAA/DFW	DFW Tower	Observer	X		
Dallas Lantz	FAA/DFW	DFW Tower	Observer	X		X

5 Conclusion

One new hazard with low risk was identified and no safety requirements were recommended by this SRMP. The OpEval has a limited scope of one year within the D10 TRACON airspace for AAL ACSS-equipped A321 aircraft on approach into DFW. The CAS-A team has identified several parameters to determine the performance and success of the operation. Those parameters, along with specific items identified for monitoring the safety risk, will provide insight to the safety and efficiency of the operation. The data collected will provide input and guidance for future safety analyses to expand this type of operation to other airlines and airports in the NAS, potentially adding to the ability to consistently maintain greater capacity rates.

Based on the single low risk hazard identified and the proposed management of the procedures involved in the CAS on Approach Operational Evaluation, it is recommended that the proposed operational evaluation supported by this SRM document proceeds.

In support of the proposed operational evaluation, AJT accepts the risks associated with the changes to phraseology. Regular procedural changes to phraseology would not normally require risk acceptance, but given the temporary nature of the phraseology change to only one specific location, risk acceptance is necessary in this instance. The responsibilities for separation of CAS-A aircraft from all other aircraft before issuance of the CAS-A instruction and after the conclusion or termination of the CAS-A operation remains with air traffic control and has no changes as a result of this operational evaluation. During the CAS-A operation, Air Traffic is responsible for separating the CAS-A aircraft from all aircraft except the designated aircraft.

In support of the operational evaluation, AFS accepts risk on behalf of the Agency and American Airlines, Inc. for use of the CDTI as a means to apply pilot-applied separations in lieu of the current standard, out the window pilot-applied visual separation.

Appendix A – Acronym List

Acronyms Used in this Document	
A321	Airbus 321 series aircraft
AAL	American Airlines
ACSS	Aviation Communication & Surveillance Systems, LLC
ADS-B	Automatic Dependent Surveillance – Broadcast
AGD	ADS-B Guidance Display
AIRS	ADS-B In Retrofit Spacing
AFS	FAA Flight Standards Service
AJI	FAA Safety and Technical Training
AJM	FAA Air Traffic Program Management
AJT	FAA Air Traffic Services
AJV	FAA Mission Support Services
AJW	FAA Technical Operations
APA	Allied Pilots Association
ATC	Air Traffic Control
ATO	Air Traffic Organization
ATPA	Automated Terminal Proximity Alert
ATSAP	Air Traffic Safety Action Program
CAMI	Confirm, Activate, Monitoring, Intervene
CAS-A	CDTI Assisted Separation on Approach
CAVS	CDTI Assisted Visual Separation
CDTI	Cockpit Display of Traffic Information
CSMM	Call Sign Mismatch
D10	Dallas/Fort Worth TRACON
DFW	Dallas/Fort Worth International Airport
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
GA	Go Around
HAW	Hazard Analysis Worksheet
IFP	Instrument Flight Procedures
ILS	Instrument Landing System
IM	Interval Management
IMC	Instrument Meteorological Conditions
IOAA	IFP Operations and Airspace Analytics
JO	Joint Order
LOC	Localizer
LTA	Letter to Airmen
MCDU	Multi-Purpose Control Display Unit
MOR	Mandatory Occurrence Report

Acronyms Used in this Document	
NAS	National Airspace System
NATCA	National Air Traffic Controllers Association
NM	Nautical Miles
NOTAM	Notice To Air Missions
OpEval	Operational Evaluation
OTW	Out the Window
PDARS	Performance Data Analysis and Reporting System
PF	Pilot Flying
PHL	Preliminary Hazard List
PM	Program Manager
POC	Point-of-Contact
SA	Situational Awareness
SBS	Surveillance and Broadcast Services
SM	Statute Mile
SME	Subject Matter Expert
SMS	Safety Management System
SOP	Standard Operating Procedures
SRM	Safety Risk Management
SRMP	Safety Risk Management Panel
STARS	Standard Terminal Automation Replacement System
TCAS	Traffic Collision Avoidance System
TMU	Traffic Management Unit
TPFID	Third-Party Flight ID
TTF	Traffic-To-Follow
TRACON	Terminal Radar Control
VMC	Visual Meteorological Conditions

Appendix B – Reference Documents

5.1 Severity Definitions

Severity is the measure of how bad the effect of the hazard is predicted to be, considering the controls in place. The severity of an outcome is assessed independently of its likelihood. Table B-1 is a copy of the Severity definitions included in the ATO SMS manual used by this SRMP.

Table B-1: Severity Definitions

Effect On: ↓	***Hazard Severity Classification*** *Note: Severities related to ground-based effects apply to movement areas only.*				
	Minimal 5	**Minor 4**	**Major 3**	**Hazardous 2**	**Catastrophic 1**
	CONDITIONS RESULITING IN ANY ONE OF THE FOLLOWING:				
ATC Services	A minimal reduction in ATC services CAT D Runway Incursion[1] Proximity Event, Operational deviation, or measure of compliance greater than or equal to 66 percent[2]	Low Risk Analysis Event severity,[3] two or fewer indicators fail CAT C Runway Incursion	Medium Risk Analysis Event severity, three indicators fail CAT B Runway Incursion	High Risk Analysis Event severity, four indicators fail CAT A Runway Incursion	Ground collision[4] Mid-air collision Controlled flight into terrain or obstacles
Flight Crew	Pilot is aware of traffic (identified by Traffic Collision Avoidance System traffic alert, issued by ATC, or observed by flight crew) in close enough proximity to require focused attention, but o action is required Pilot deviation[9] where loss of airborne separation falls within the same parameters of a Proximity Event or measure of compliance greater than or equal to 66 percent Circumstances requiring a flight crew to initiate a go-around	Pilot deviation where loss of airborne separation falls within the same parameters of a Low Risk Analysis Event severity Reduction of functional capability of aircraft, but overall safety not affected (e.g., normal procedures as per Airplane Flight Manuals) Circumstances requiring a flight crew to abort takeoff (rejected takeoff); however, the act of aborting takeoff does not degrade the aircraft performance capability Near mid-air collision encounters with separation greater than 500 feet[10]	Pilot deviation where loss of airborne separation falls within the same parameters of a Medium Risk Analysis Event severity Reduction in safety margin or functional capability of the aircraft, requiring flight crew to follow abnormal procedures as per Airplane Flight Manuals Circumstances requiring a flight crew to reject landing (i.e., balked landing) at or near the runway threshold Circumstances requiring a flight crew to abort takeoff (i.e., rejected takeoff); the act of aborting takeoff degrades the aircraft performance capability Near mid-air collision encounters with separation less than 500 feet[10]	Pilot deviation where loss of airborne separation falls within the same parameters of a High-Risk Analysis Event severity Reduction in safety margin and functional capability of the aircraft requiring flight crew to follow emergency procedures as per Airplane Flight Manuals Near mid-air collision encounters with separation less than 100 feet[10]	Ground collision Mid-air collision Controlled flight into terrain or obstacles Hull loss to manned aircraft Failure conditions that would prevent continued safe flight and landing

Effect On: ↓	***Hazard Severity Classification*** *Note: Severities related to ground-based effects apply to movement areas only.*				
	Minimal 5	**Minor 4**	**Major 3**	**Hazardous 2**	**Catastrophic 1**
	CONDITIONS RESULITING IN ANY ONE OF THE FOLLOWING:				

1. Refer to the current version of Order 7050.1, *Runway Safety Program*.
2. Proximity Events and Operational Deviations are no longer used to measure losses of separation, but they are applicable when validating old data. The minimal loss of standard separation is now represented as a measure of compliance of greater than or equal to 66 percent.
3. Risk Analysis Event severity indicators are as follows:
   a. Proximity. Failure transition point of 50 percent of required separation or less.
   b. Rate of Closure. Failure transition point greater than 205 knots or 2,000 feet per minute (consider both aspects and utilize the higher of the two if only one lies above the transition point).
   c. ATC Mitigation. ATC able to implement separation actions in a timely manner.
   d. Pilot Mitigation. Pilot executed ATC mitigation in a timely manner.
4. An effect categorized as catastrophic is one that results in a fatality or fatal injury.
5. Ground Collision. An airplane on the ground collides with an object or person.
6. Minor Injury. Any injury that is neither fatal nor serious.
7. Serious Injury. Any injury that: a. Requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received.
   a. Results in a fracture of any bone (except simple fractures of fingers, toes, or nose).
   b. Causes severe hemorrhages, nerve, muscle, or tendon damage.
   c. Involves any internal organ; or
   d. Involves second or third-degree burns, or any burns affecting more than five percent of the body's surface.
8. Fatal Injury. Any injury that results in death within 30 days of the accident.
9. Refer to Order JO 8020.16, *Air Traffic Organization Aircraft Accident and Incident Notification, Investigation, and Reporting*, for more information about pilot deviations.
10. Near mid-air collision definitions are derived from FAA Order 8900.1, *Flight Standards Information Management System*, Volume 7, which defines the following categories: critical, potential, and low potential. Refer to Section 9 for the complete definitions of these categories.

5.2 Likelihood Definitions

Table B-2 is a list of the qualitative likelihood category definitions from the ATO SMS manual that were used to assess the hazard in this SRM document.

Table B-2: Likelihood Definitions

	Operations: Expected Occurrence Rate (Calendar-based)
	(Domain-wide: NAS-wide, Terminal, or En Route)
Frequent A	Equal to or more than once per week
Probable B	Less than once per week and equal to or more than once per three months
Remote C	Less than once per three months and equal to or more than once per three years
Extremely Remote D	Less than once per three years and equal to or more than once per 30 years
Extremely Improbable E	Less than once per 30 years

Appendix C – Hazard Analysis Worksheet

CAS-A 2022 SRMP Preliminary Hazard Analysis for D10 Operational Evaluation – Hazard Analysis Worksheet

Hazard ID	Hazard Description	Hazard Cause	System State	Controls	Control Justification	Effects	Severity	Severity Rationale	Likelihood	Likelihood Rationale	Initial Risk	Safety Requirement Description / Plan to Implement?	Organization Responsible/ Point of Contact	Predicted Residual Risk / Rationale	Safety Performance Target
CAS-1	Designate the wrong TTF	Incorrect Flight ID provided Incorrect selection Flight ID is incorrect (CSMM)	All	ATC Radar Monitoring ATPA Hear-back/read-back (ATC/AAL phraseology training and procedures) ATC Track Conformance Tool Final Monitor Position TCAS Flight Crew Verification of information PF makes input, Pilot Monitoring verifies (CAMI - Confirm, Activate, Monitoring, Intervene) Avionics software Flight Deck Traffic Display	SMEs provided input on all of the tools available to them currently in the TRACON and on the flight deck	CAS-A and TTF too close to apply runway separation Increased communication /Increased workload Loss of SA on flight deck Loss of separation with another aircraft	5 – (Minimal) 5 – (Minimal) 5 – (Minimal) 4 – (Minor)	Requiring a GA SME input	D – (Extremely Remote) C – (Remote) C – (Remote) D – (Extremely Remote)	SME input	5D – (Low) 5C – (Low) 5C – (Low) 4D – (Low)	None	None	5D – (Low) 5C – (Low) 5C – (Low) 4D – (Low)	see Monitoring Plan

Appendix D – Operational Description

See https://www.faa.gov/media/92356