# ADS-B In Retrofit Spacing (AIRS) CDTI Assisted Separation on Approach (CAS-A) Single Runway Operational Description

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Federal Aviation Administration
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Aviation Communication & Surveillance Systems, LLC
NextGen Project

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# 1 Background

The FAA Surveillance and Broadcast Services Group is interested in promoting the adoption of Automatic Dependent Surveillance-Broadcast In (ADS-B In) applications that can increase safety and efficiency in the NAS. To that end, the Federal Aviation Administration (FAA), American Airlines, Inc. (AAL) and Aviation Communication & Surveillance Systems, LLC (ACSS) entered into an agreement (DTFAWA-17-A-80009) on September 21, 2017 to support the evaluation of ADS-B In operations with the American Airlines A321 and A321 Neo fleet. The ADS-B In operations being evaluated are CDTI[1]-Assisted Visual Separation (CAVS), CDTI-Assisted Separation (CAS) 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 is 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 implementation on forward fit aircraft. AAL installed the ACSS system, called SafeRoute+™, on the entire A321 fleet.

This document is an operational description of CDTI Assisted Separation on Approach (CAS-A) to a single arrival runway at Dallas Fort-Worth International Airport (DFW). The FAA, AAL, and ACSS are developing a separate document for the operational description of I-IM. The operational description will be used to support the Safety Risk Management Panels that will be needed before CAS operations are approved and to assist the trial site in developing Standard Operating Procedures (SOP). CAVS is already an approved operation in the NAS, per OPSPEC/MSPEC/LOA A355 and FAA Advisory Circular 90-114B, Appendix B. A safety review was performed by the FAA Flight Technologies and Procedures Division (AFS-400) and is contained in the CAVS Operational Safety Assessment (OSA), dated April 9, 2013.

# 2 Overview of CAS Operation

To increase runway capacity, operations at some airports are enhanced by relieving the controller of the requirements to apply radar separation using visual separation from Traffic-To-Follow (TTF). The objective of CAS is to maintain visual-like separation more safely and efficiently from TTF via the CDTI during approach procedures. It is expected to recapture some of the runway capacity benefits of visual separation operations during weather conditions that do not support visual approaches by relieving the controller of radar separation responsibility and during visual approach conditions or when identification of the TTF out the window (OTW) may be delayed.

CAS builds on the existing CAVS operation, as described in AC 90-114B (Automatic Dependent Surveillance-Broadcast Operations) and the same flight deck tools are used for both CAS and

[1] Cockpit Display of Traffic Information

CAVS. CAVS allows flight crews to use information on the CDTI as a substitute for continuous visual observation of TTF during Visual Meteorological Conditions (VMC). Once the flight crew has visually acquired and accepted a visual approach clearance behind TTF, the pilot can use the information on the CDTI as a means for maintaining separation during a visual approach when OTW visual contact cannot be maintained. The CAVS operation is transparent to the controller.

The CAS operation is initiated by the controller, who provides an approach clearance and a CAS instruction that includes the Flight ID[2] for the traffic-to-follow. The flight crew identifies the TTF on the CDTI based on the Flight ID provided by the controller, and visual acquisition is not required. After traffic identification and designation, the controller is relieved of the requirement to apply radar separation and the flight crew follows the TTF using the information available on the CDTI.

CAS can only be used when both aircraft are approaching the same runway at an airport that has a reported ceiling of 1000 feet or greater and visibility of 3 Statue Miles (SM )or greater. The aircraft conducting a CAS operation may enter Instrument Meteorological Conditions IMC conditions during flight, unless on a visual approach, where the aircraft must remain clear of clouds.

CAS applies when the CAS Aircraft and TTF are flying an approach. CAS does not change any requirements for instrument or visual approach procedures. It relieves the controller of the requirement to apply radar separation from the preceding TTF on approach when OTW visual contact would not be possible by the flight crew. When the CAS aircraft is on a visual approach, CAS does not change any requirements in the Federal Aviation Regulations (FAR), which dictate under what conditions the flight crew can accept the visual approach clearance. Acquisition of the lead OTW is purely coincidental and does not affect the CAS operation.

The application is mainly intended for air transport aircraft arriving at capacity-limited airports, but it can be used by all capable aircraft during approach to any airports where instructions for maintaining pilot-applied visual separation from the TTF are used. CAS does not change any pilot procedures or responsibilities related to wake turbulences.

## 3 Context of CAS Operation

In current operations, there is expected to be an increase in landing capacity and/or increase in the number of movements when controllers can precondition aircraft so that flight crews can use pilot-applied visual separation against TTF during approach. In the United States, this often occurs during visual approach operations. Arrival rates at airports in the U.S. are significantly higher when controllers can count on visual separation provided by the flight crew. Two factors contribute to this:

- When the controllers know that flight crews can conduct pilot-applied visual separation, they are able to provide closer spacings over the runway threshold, delivering aircraft at appropriately closer distances on long final approach to take advantage of this tighter eventual spacing. After this controller set-up, flight crews manage their speed to maintain a safe landing interval.

[2] Also known as “call sign”, combining the ICAO airline designator (and telephony) with the flight number to derive the Flight ID, such as “American Four Fifty-Six” for AAL456.

- When flight crews can conduct visual separation, controllers deliver spacings over the runway threshold that are consistently closer than they are able to do when the controller must apply standard separation.
    - For example, the minimum spacing achieved over the 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 spacing provided by the controller who must include some additional spacing above the minimum separation requirement of either 2.5 or 3 NMs[3] to avoid separation issues during a non-visual operation. This additional spacing results in gaps between successive arrivals of 3 to 4 NM.

**Note**: 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 7110.65 Para. 3-10-3. During instrument approach operations, the primary influence is radar separation, as defined in FAA JO 7110.65 Para. 5-5-4. Since approach controllers are responsible for separation to the runway threshold, they apply a buffer in excess of separation minima due to the uncertainty of arrival aircraft final approach speed.

In the current system, the higher capacity rates are lost, not at basic VMC minima, but at visual approach minima which are considerably higher than the basic VMC minima at airports[4] as shown in Figure 3-1.

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

[3] Except in cases where Wake Turbulence separation must be applied, standard radar separation in terminal airspace is 3 NM. FAA JO 7110.65 para. 5-5-4 j allows the use of 2.5 NM within 10 NM of the landing runway when the listed conditions are met.

[4] Typical visual approach minima range from about a 2500 ft ceiling and 4 miles of visibility to over a 5000 ft ceiling and 10 miles of visibility, depending on the US airport.

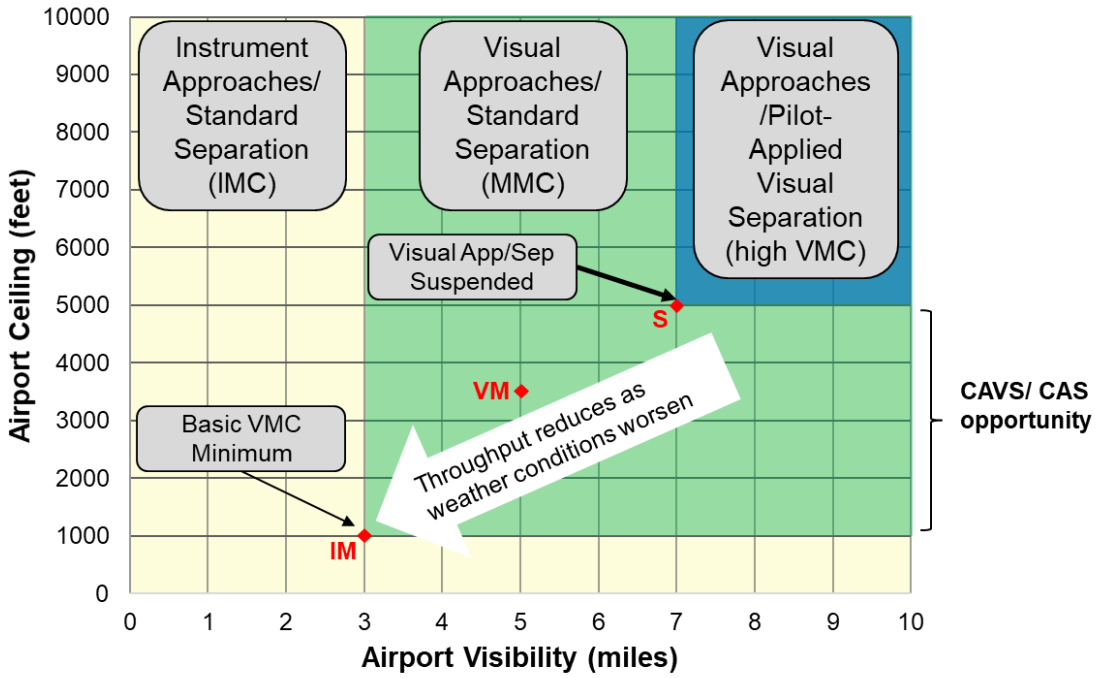


*Figure 3-1 - Weather Conditions for Visual Approach Operations in the United States*[5]

The airport's acceptance rates are highest when they conduct visual approach operations. Visual approaches can be conducted when conditions are at least 500 feet above minimum vectoring altitudes (MVA). This is shown by point VM in Figure 3-1. This is a theoretical number. The actual minima below which a facility cannot reliably conduct, and therefore suspends visual approach operations, depends on when flight crews cannot dependably visually navigate for the approach or visually acquire other aircraft. Since combining instrument and visual approaches presents challenges for the controller, a relatively small percentage of arrivals not being able to visually acquire the airport, or the TTF, can result in suspension of visual approach operations and the correspondingly higher arrival rate.

The point below which a facility suspends visual operations is usually considerably higher than this theoretical minimum of MVA, plus 500 feet. This is shown by the point S in Figure 3-1**.** In actual operations, the facility generally must conduct an instrument operation with lower arrival rates when below point S, which is often considerably higher than the basic VMC minima of 1000 feet and three miles (point IM in Figure 3-1).

For example, when DFW operates on runways 13R|18R|17C|17L in "good visual" conditions for visual approaches (i.e., at least above 3500 feet and 5 miles), the rate, known as the Airport Acceptance Rate[6] (AAR), is 114. This reduces to an AAR of 102 in IMC.

CAVS is expected to help close the gap somewhere between points S and point VM in Figure 3-1. However, since controllers may not know whether an aircraft is capable of CAVS, it will likely be difficult for the controller to expect CAVS operations when all other aircraft have

[5] Figure 3-1 is a general representation of airports in the NAS.

[6] The number of arriving aircraft an airport or airspace can accept from an air route traffic control center (ARTCC). It is the determining parameter to calculate the desired interval between successively arriving aircraft.

switched to an instrument operation. Furthermore, controllers generally do not simultaneously conduct visual approach and instrument approach operations. Once a small percentage of arrivals indicate they are unable to visually acquire the TTF, all arrival traffic is transitioned to instrument approach operations.

Additionally, CAVS probably cannot bring the higher capacity point all the way down to point IM in Figure 3-1, since the suspension of visual operations may occur either because the CAVS Aircraft may lose visual meteorological conditions or is not able to initially acquire the traffic OTW. CAS will overcome these limitations by relieving the controller of the requirement to apply radar separation during these conditions. CAS will enable the facility to approximate the visual operation rates to a 1000 foot cloud base and 3 SM of visibility.

Results documented by (Lunsford, et al., 2005) and (Coates, et al., 2018) indicate that the capacity gains from CAS would be on the order of 4% to 12% higher (depending on the airport) than the rates now seen in conditions where visual operations cannot be conducted. In addition to the capacity gain, the information provided on the CDTI (e.g., Flight ID, differential ground speed, and distance to TTF) greatly enhances the flight crew's ability to identify, acquire, track, and space from the TTF. CAS will enhance traffic awareness and the positive identification of the TTF.

The realization of the capacity gain benefits will be a function of the percentage of the traffic that is equipped with CAS equipment. As equipage increases, the benefits will increase, as a facility's Traffic Management Unit is expected to increase the AAR. Early adopters could experience CAS benefits at hub airports where the operator has a high percentage of the traffic.

## 4 Objective of CAS Operation

The objective of CAS is for controllers and flight crews to safely perform following on approach operations more efficiently, on a more regular basis, and in new conditions by:

- Allowing controllers to set up an arrival sequence and interval that optimizes the arrival capacity.
- Making it easier and more reliable for flight crews to acquire the TTF. The CDTI (with Flight ID and designation) is used by the flight crew to identify the TTF provided by the controller.
- Confirming that flight crews choose the correct traffic by verifying the Flight ID provided by the controller corresponds to that on the CDTI.
- Supporting flight crews in following the TTF on approach using the CDTI.
    - To maintain a safe, but not excessive, aircraft spacing and to detect unexpected speed reductions of the TTF are difficult tasks. The CDTI will continuously provide range and differential ground speed with respect to the TTF that will support the flight crews in performing these tasks more efficiently and safely.
- Authorizing flight crews to conduct the task of following TTF using solely the information provided by the CDTI, including when the CAS Aircraft enters or is in IMC during Instrument Approach procedures, or has not reported the TTF in sight OTW during Visual Approach procedures.

Authorizing the flight crew to use the information provided by the CDTI when OTW visual contact is not possible (or is lost) is expected to increase the number of visual separation-like operations. This is due to the flight crew having greater confidence that they will be able to perform the full approach and track the TTF. It is expected that flight crews will be more inclined to accept a CAS instruction in situations where such operations are currently suspended while the actual minima for the operation are still met, or when the conditions do not allow for the application of pilot-applied visual separation. This type of operation will contribute to the ability to consistently maintain greater capacity rates during marginal weather conditions.

The flight crew is expected to use the CDTI to track the TTF, as is currently done OTW, and to make determinations of when to make the final decelerations to final landing speeds utilizing the additional information on the TTF provided on the CDTI. The roles and responsibilities of conducting visual separation from the TTF are not changed with CAS.

# 5 Procedure Description

## 5.1 Procedure Overview

CAS is comprised of four phases: TTF Identification and Verification; Instruction for Maintaining CAS from the TTF; Maintaining CAS on the Approach; and Termination.

At the beginning of the operation, the flight crew designates[7] on the CDTI the traffic that they identify to be the TTF based on the Flight ID provided by the controller. Once the aircraft is designated and the CAS operation starts, the CDTI provides additional information (e.g., differential ground speed, and distance from TTF).

## 5.2 Phase Descriptions and Diagrams

Descriptions and diagrams of the four phases are provided in this section. The associated tables are shown in Appendix C.

The following convention is used to indicate who or what is responsible for the task:

- GND-Pro = A task performed specifically by the ground processing equipment
- GND-ATCo = A task performed specifically by the Air Traffic Controller
- GND = A task performed either by ground processing equipment or by Air Traffic Controller or by a combination of both
- AC-Av = A task performed specifically by the aircraft avionics
- AC-FC = A task performed specifically by the aircraft flight crew
- AC = A task performed either by the aircraft avionics or by the flight crew or by a combination of both

### 5.2.1 TTF Identification and Verification (Phase 1)

The CAS procedure is initiated by the controller and who has assessed the applicability of providing an instruction for maintaining CAS from the TTF.

The objective of this phase is that, at the end, the flight crew of the CAS Aircraft has:

- Designated traffic on the CDTI corresponding to the TTF; *and*
- Verified the CDTI information matches the Flight ID provided by the controller.

**Note**: The identification and verification step communicates the Flight ID to the flight crew, allows the flight crew to identify and designate the TTF, and ensures the correct TTF is identified. This is a mandatory step and needs to be completed prior to the issuance of the CAS instruction.

[7] The flight crew designates traffic from the MCDU Traffic Information page by selecting the Select ON/OFF prompt shown in Figure G 4.

#### 5.2.1.1 Procedure Initiation

The CAS equipage status is available to the controllers so they know which aircraft they can plan to apply CAS operations.[8]

The procedure for the flight crew of the CAS Aircraft during the TTF identification phase includes the use of the CDTI.

On receipt of the Flight ID provided by the controller, the flight crew:

- looks at the CDTI to identify and select traffic corresponding to the TTF Flight ID.
- if the identity of the TTF is in question,
    - confirms with the controller the identity of the TTF.
- if identification is not achieved,
    - informs the controller that detection and/or designation of the traffic-to-follow is not possible.

If no traffic is displayed that corresponds to the TTF, if the traffic corresponding to the TTF is not qualified to support CAS, or if the flight crew elects not to utilize the CDTI, CAS is abandoned, the flight crew advises the controller, and the controller utilizes alternate procedures.

**Note**: At any point in the traffic identification process, the flight crew can verify the Flight ID of the TTF with the controller if there are any questions about the TTF location or identity.

[8] The methodology for controller awareness of avionics equipage is contained in Appendix E.

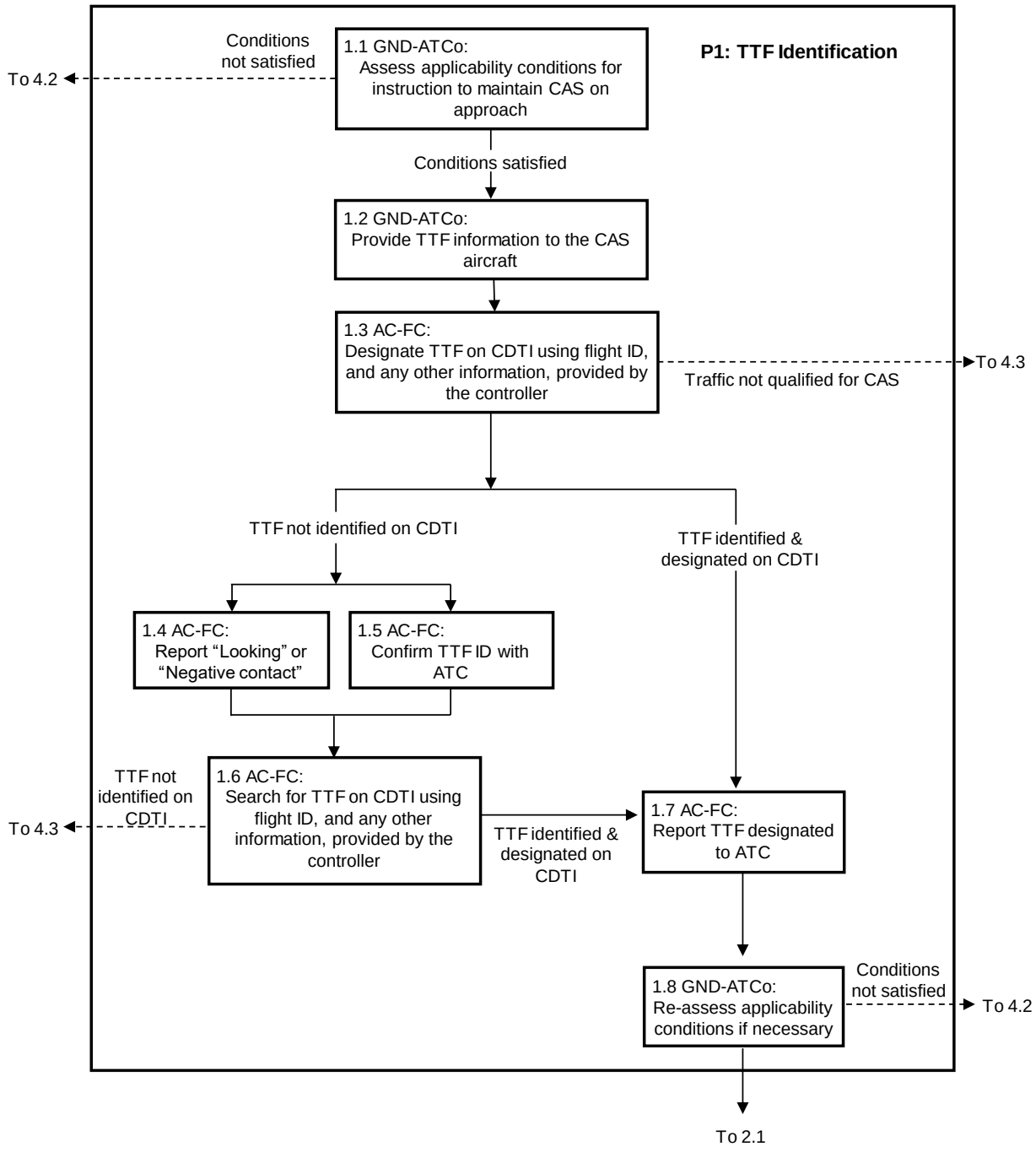


*Figure 5-1 - TTF Identification Phase (Controller Initiative)*

### 5.2.2 Instruction for Maintaining CAS from the TTF (Phase 2)

CAS has two tasks in this phase: the designation of the displayed traffic corresponding to the TTF and initiating the CAS operation. In Figure 5-2 below, it is presented as being done before, but it would not have any impact on the requirements if it were done after.

**NOTE**: The designation can also be done during the TTF Identification phase. This would have no impact on the requirements.

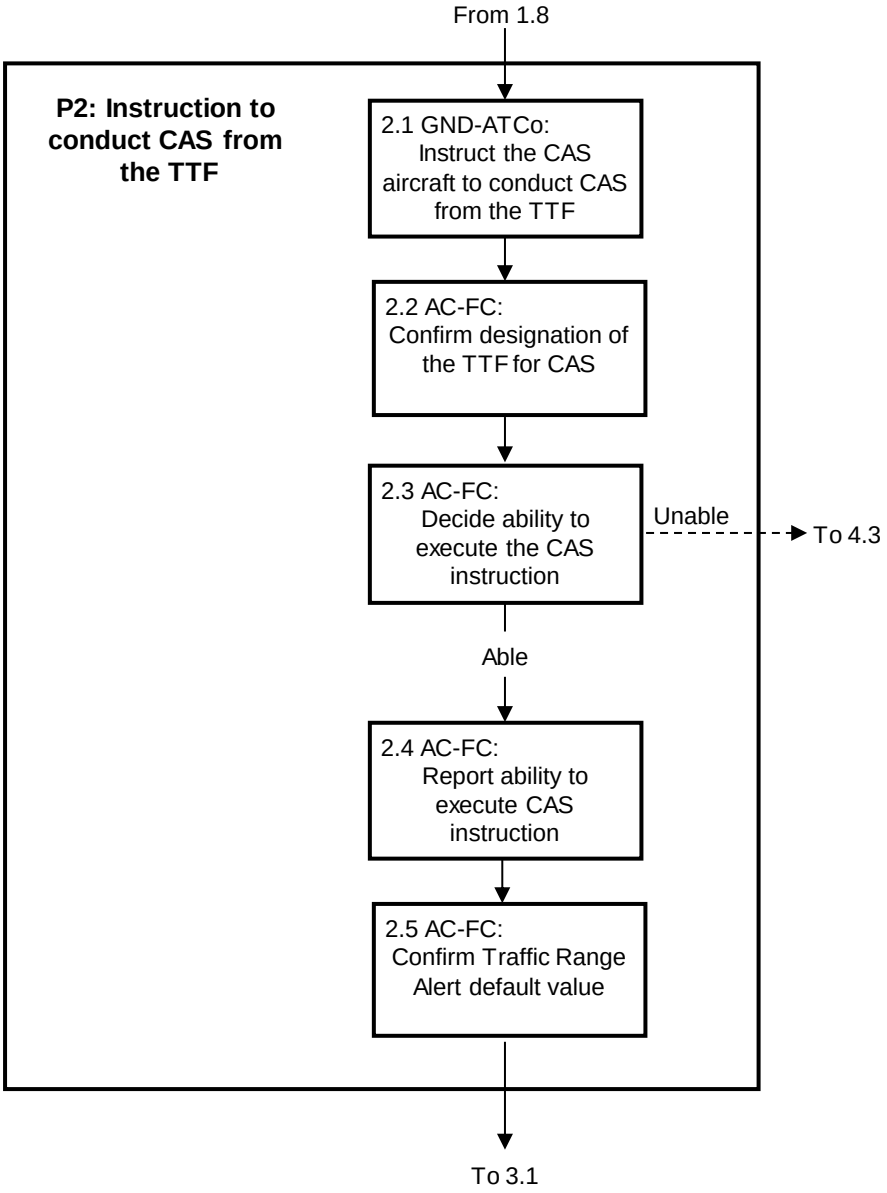


*Figure 5-2 - Instruction for Maintaining CAS from the TTF Phase*

### 5.2.3 Maintaining CAS on the Approach (Phase 3)

The flight crew uses the information provided by the CDTI on the lead traffic in substitution for the OTW information to follow, as done today on visual approaches via CAS. The CDTI is used by the flight crew in performing this task by providing in the Forward Field of View the ground speed information (i.e., the individual ground speeds and the differential ground speed at the minimum when the aircraft are in-trail of each other) and the digital read-out of the horizontal range to the designated traffic. These parameters allow for a better evaluation of the actual distance from the TTF and for an earlier detection of speed variations. In particular, a speed reduction of the TTF is extremely difficult to detect visually OTW and only the consequence (i.e., a distance reduction) can be visually detected. Using the range and differential ground speed information on the AGD, flight crews will be able to detect speed reductions of the TTF and maintain CAS more accurately and quickly.

The flight crew may use speed adjustments as needed to manage the spacing between their aircraft and the TTF. The CAS Aircraft may not use turns or lateral maneuvering as a means to manage spacing with the TTF without ATC Coordination. Only such maneuvering as needed to capture and maintain the final approach course is acceptable.

If visual OTW contact is achieved at any point, the flight crew may use this information for situational awareness but should not rely on OTW contact to conduct CAS operations. Once CAS has started, the CAS operation will end when:

- The TTF lands; or
- Traffic Lost Advisory Alert; or
- Cancellation of CAS by ATC; or
- Cancellation of CAS by the flight crew.

**Note**: It is an on-going task of the controller to ensure the requirements for the weather conditions at the airport for CAS operations are met.

Three alerting[9] functions are provided in support to CAS operations.

1. An operational advisory "Traffic Range" alert is generated when the horizontal range to the designated traffic falls below the default value.[10]. When an advisory "Traffic Range" alert is generated, the flight crew must determine if any subsequent response is required.

**NOTE**: Subsequent flight crew responses could include adjusting speed to continue the approach or contact ATC for non-visual separation/non-CAS instructions.

2. A technical performance "Traffic Minimum Range Caution Alert" is generated when the horizontal range to the designated traffic becomes less than 1.4 NM. The objective is to alert the flight crew ADS-B Out Data quality is no longer sufficient to maintain CAS from the TTF. When a "Traffic Minimum Range Caution Alert" is triggered, the flight crew must:

[9] Additional information on avionics alerting is contained in Appendix D - Definitions.

[10] When traffic is designated, the range alert threshold will be displayed with a default value of 2.5 NM. The flight crew can modify the default value by entering a valid value (1.4 - 10 NM) to the field.

- Contact ATC; if unable to contact ATC, execute a missed approach or go-around.
- If, when contacting ATC, the flight crew has OTW visual contact, advise the controller, who may elect to issue a visual separation instruction.

3. A Traffic Lost advisory alert is generated when the TTF is no longer qualified to support CAS, due to the ADS-B Out signal not meeting performance parameters. The flight crew must:
    - Contact ATC; if unable to contact ATC, execute a missed approach or go-around.
    - If, when contacting ATC, the flight crew has OTW visual contact, advise the controller, who may elect to issue a visual separation instruction.

**NOTE:** No alerts will be 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 lands during a CAS operation, the "Traffic Range" and "Traffic Minimum Range" alerts are disabled, the differential groundspeed is removed from the AGD, and the TTF symbol changes from a green double chevron to a brown double chevron[11].

After having accepted the instruction for maintaining CAS from the TTF, the flight crew:

- Flies the approach; *and*
- Looks at the information (i.e., distance and relative speed) on the TTF provided by the CDTI; *and*
- Reacts to any alerts as appropriate; *and*
- Adjusts the speed of the aircraft to maintain CAS from the TTF.

The procedure in case of abnormal modes (e.g., TTF no longer qualified to support CAS, or triggering of a "Traffic Minimum Range Caution Alert" without OTW visual contact) is identical to the current visual approach with TTF (e.g., loss of visual contact and/or too close from the TTF).

[11] Display conventions described are specific to ACSS avionics.

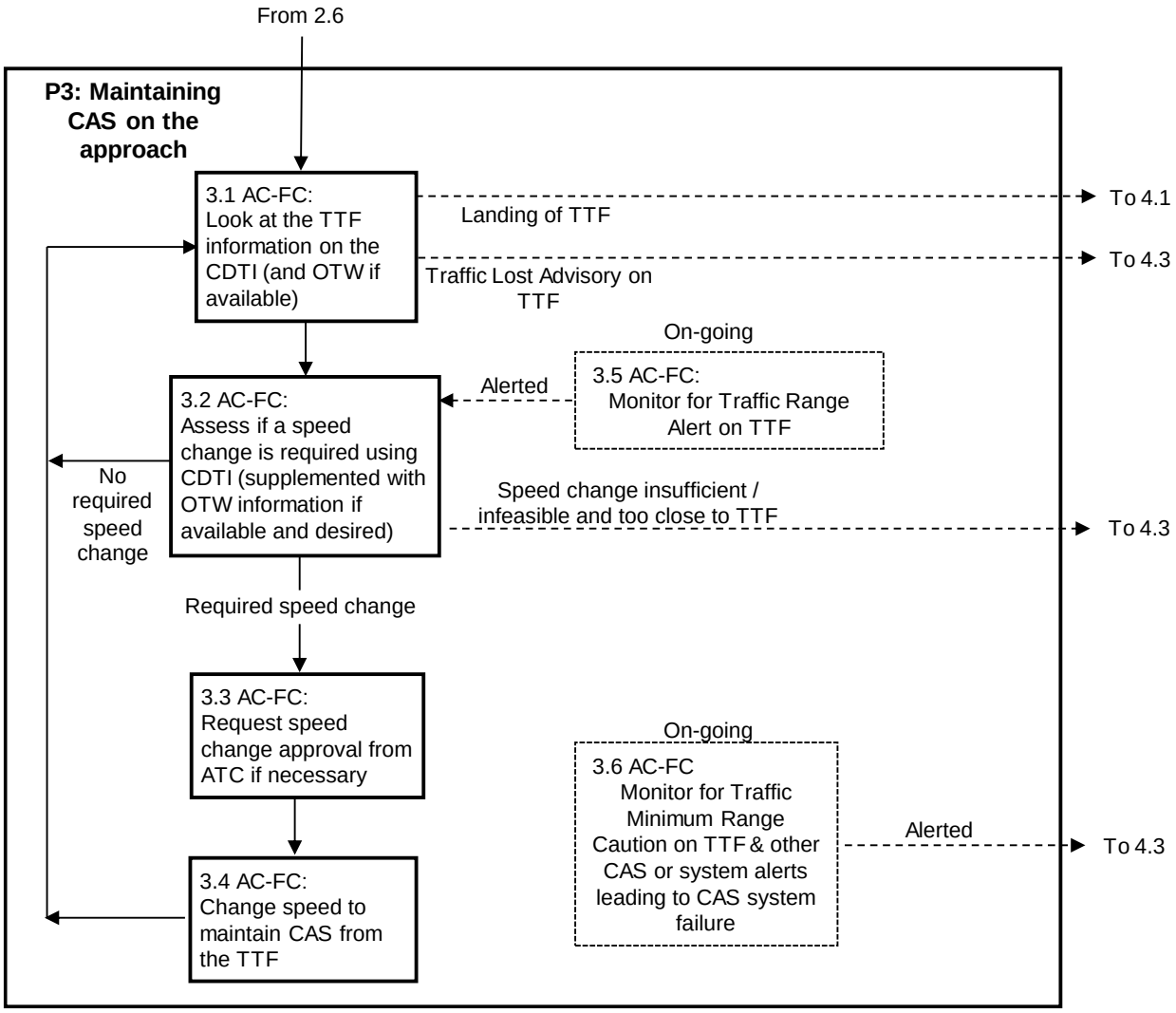


*Figure 5-3 - Maintaining CAS on the Approach Phase*

### 5.2.4 Termination (Phase 4)

CAS nominally ends when the TTF lands. CAS can also end abnormally. In current operations, one of the reasons for abnormal termination of visual separation instructions occurs when the flight crew perceives visually that the distance from the TTF becomes unsafe. In such situations, the flight crew applies contingency procedures (e.g., increase distance, conduct a missed approach, go-around or contact ATC). Since CAS allows for the use of the CDTI information as a substitute for OTW visual information, the current contingency procedures also apply when the flight crew perceives that the distance from the TTF becomes too small using the information provided by the CDTI (e.g., displayed parameters, advisory "Traffic Range" alert) or when a "Traffic Minimum Range Caution Alert" is triggered.

Another CAS event leading to an abnormal termination is the loss of support from the CDTI (e.g., TTF no longer qualified to support CAS). In this situation, the flight crew applies the same contingency procedures as in current visual approach with TTF operations when the flight crew loses OTW visual contact (e.g., conduct a missed approach, go-around or contact ATC).

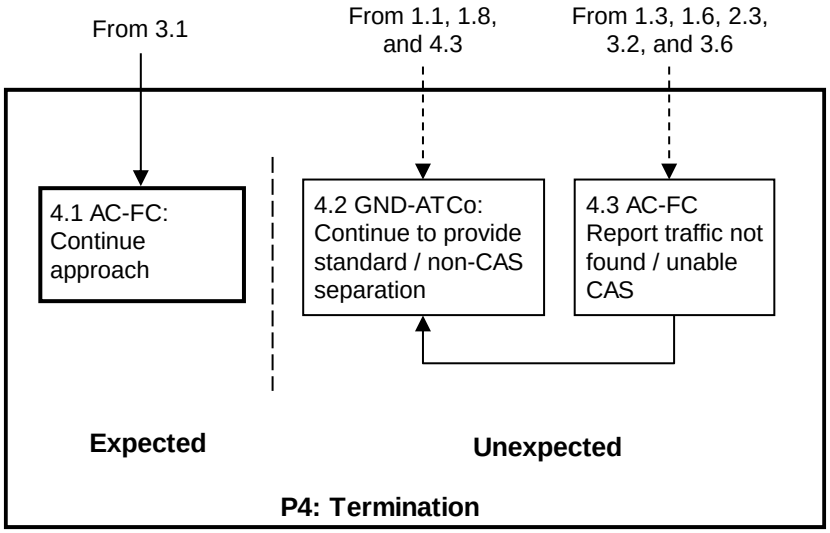


*Figure 5-4 - Termination Phase*

## 5.3 Roles and Responsibilities

### 5.3.1 Air Traffic Controller

The roles and responsibilities of the Approach and Tower Controllers for the current operations where flight crews maintain visual separation from the TTF are still valid. The controller remains responsible for setting up the sequence and the spacing so the CAS operation will be successful and maximum capacity is achieved.

During visual approach operations, controllers position aircraft to meet the following criteria:

- Likely to be clear of clouds; *and*
- On a published approach procedure so that the flight crew can use the instrument approach as a back-up to the visual clearance; *and*
- Limit the turn on to final to 30 degrees or less to comply with FAA JO 7110.65 procedures for separation between parallel runways, when applicable; *and*
- Establish an orderly sequence.

Using CAS during visual approaches will make use of these procedures.

The condition necessary for the controller to issue a CAS clearance is the designation of the TTF. In addition, both the CAS and TTF must be established on the final approach course, be established on an arrival procedure that connects to the final approach course, or vectored to intercept the final approach course. The CAS instruction must be issued after the issuance of the approach clearance, whether in the same or in a later transmission.

Before the flight crew of the CAS Aircraft has accepted the instruction to maintain CAS from the TTF, the controller is responsible for providing separation between both aircraft. When advising the flight crew of the CAS aircraft, the controller will use the Flight ID of the TTF. After having accepted the CAS instruction, the flight crew of the CAS Aircraft becomes responsible for maintaining CAS from the TTF. The controller remains responsible for providing separation between the CAS Aircraft and all other aircraft for which they have separation responsibility. The controller monitors the spacing for any significant issues but allows the flight crew of the CAS Aircraft to apply CAS from the TTF. The Tower Controller is still responsible for runway separation and issuing landing clearances for all the aircraft pairs, including the CAS pair.

A responsibility that remains for the controller is the issuance of Safety Alerts. The following two paragraphs of FAA JO 7110.65 apply to Safety Alerts and are not modified or affected by the use of CAS.

**Para. 2−1−2. DUTY PRIORITY**

Give first priority to separating aircraft and issuing **safety alerts** [emphasis added] 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** [emphasis added]. 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** [emphasis added]**.** 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.*

1. *Recognition of situations of unsafe proximity may result from MSAW/E−MSAW, automatic altitude readouts, Conflict/Mode C Intruder Alert, observations on a PAR scope, or pilot reports.*
2. *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 of the CAS Aircraft reports that CAS can no longer be maintained, the same contingency procedure used in today's operations applies. That is, after having been informed by the flight crew of the CAS Aircraft, the controller becomes responsible for providing appropriate instructions to establish another form of separation between the two aircraft as the spacing achieved visually from the TTF is usually less than other ATC more restrictive separation minima.

As with other current day operations, the controller needs to ensure the requirements for the weather conditions at the airport for CAS operations are met.

### 5.3.2 Flight Crew

The flight crew is responsible for conducting CAS from the TTF via information on the CDTI, such as range and differential ground speed. The flight deck procedures include the flight crew's use of the CDTI to assist in identifying the TTF with Flight ID and to support maintaining CAS from it. The flight crew is also responsible for notifying the controller if they cannot accept a visual approach clearance.

The flight crew of the CAS Aircraft must still undertake the appropriate actions to maintain CAS from the TTF. If it is no longer possible for the flight crew of the CAS Aircraft to maintain CAS, the flight crew must also inform the controller as soon as possible and must proceed 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.

**Note**: If it becomes necessary for a flight crew to terminate a CAS instruction, due to equipment failure or for other reasons, but can maintain visual separation from the TTF, the flight crew may advise the controller they are able to maintain visual separation for the remainder of the approach. The controller will either issue a visual separation instruction or provide other instructions.

If visual OTW contact is achieved at any point, the flight crew may use this information to supplement the CAS operation and for situational awareness. Once CAS has started, the CAS operation will end when:

- The TTF lands; or
- Traffic Lost Advisory Alert; or
- Cancellation of CAS by ATC; or
- Cancellation of CAS by flight crew.

## 5.4 Phraseology

When the flight crew is unable to monitor the designated traffic on the CDTI (i.e., they can no longer maintain CAS), the flight crew will inform the controller. If the flight crew deems the inability to monitor the designated traffic on the CDTI to be a temporary condition, they may inform the controller of the cause using plain language.

There are no changes to the approach clearances.

### 5.4.1 Identification of Traffic-To-Follow

For the traffic-to-follow identification portion of the CAS instruction, controllers will use the Flight ID of the TTF when identifying that aircraft. The use of other information, such as distance and clock position, is at the discretion of the controller.

**Note**: There is a potential for flight crews to be unaware of the three-letter designator associated with the Flight ID. Controllers may use a phonetic or individual letter version of the Flight ID for clarification (e.g., "Romeo-Papa-Alpha" or "R-P-A" for Brickyard)

**Note**: In order to minimize the use of Third-Party Callsigns[12], it is preferable to limit the flight crew use of the TTF callsign to the Verification of Traffic-To-Follow step.

- ATC Message: "[CAS aircraft Flight ID] DESIGNATE [TTF Flight ID]"
- Example: "*American 452, Designate Southwest 387*"
- Example: *"American 452, Designate R-P-A 3732"*

**Note**: The flight crew will acknowledge with their aircraft identification, either at the beginning or at the end of their transmission, and one of the words "Wilco," "Roger" or other appropriate remark.

### 5.4.2 Verification of Traffic-To-Follow

ATC must receive confirmation of the Flight ID of the Traffic-To-Follow prior to issuing the CAS Instruction. This requirement ensures that ATC and the flight crew concur on the Flight ID prior to the controller being relieved of the requirement to apply radar separation.

[12] Third Party Flight ID is the potential for confusion while during a communication exchange between ATC and a flight crew, the call sign of another aircraft is used, and the flight crew of that aircraft responds. (i.e. "American 755, designate United 345")

- Flight Deck Message: "[CAS Aircraft Flight ID] HAS DESIGNATED [TTF Flight ID]"
- *Example: "American 452 has designated Southwest 387"*

If confirmation of the TTF Flight ID is not received from the flight crew prior to issuing the CAS clearance, the controller must ensure with the flight crew that the correct traffic is designated:

- ATC Message: "[CAS aircraft Flight ID] VERIFY TRAFFIC IS DESIGNATED"
- Example: "*American 456 verify traffic designated*"
- Flight Deck Message: "[CAS aircraft Flight ID] HAS DESIGNATED [TTF Flight ID]"
- Example: "*American 456 has designated Southwest 123*"

### 5.4.3 CAS Instruction

The CAS instruction must be issued after the issuance of the approach clearance, whether in the same or in a later transmission.

**Note**: CAS is directly analogous to pilot-applied visual separation as defined in FAA Order 7110.65. Like pilot-applied visual separation, CAS relieves the approach controller from having to enforce the otherwise-applicable surveillance separation minima. The approach controller monitors the CAS operation and provides speed instructions to the flight crew as the controller deems necessary.

**Note**: To avoid providing the flight crews with too much information at once, ATC should use good judgement when combining the Approach Clearance with the CAS Instruction.

**Note:** Controllers often issue a speed instruction along with a pilot-applied visual separation clearance (e.g., *…follow the Southwest Boeing 737, Cleared Visual Approach Runway Three-Three-Left, Maintain one-seven-zero knots to the marker*). 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 preceding traffic[13]. These same procedures are expected to be performed during CAS operations.

<u>CAS Instruction in same Transmission as Approach Clearance</u>

- ATC Message: "[CAS aircraft Flight ID], [Approach Clearance] FOLLOW TRAFFIC"
- Example: "*American 452, Six miles west of JEANS, turn left heading one-three-zero, maintain three thousand until established on the localizer, cleared ILS Runway one-zero approach, follow traffic*"
- Flight Deck Message: "[CAS Aircraft Flight ID], [Approach Clearance] FOLLOWING (or FOLLOW) TRAFFIC"
- Example: *"American 452, heading one-three-zero, maintain three thousand until established, cleared ILS one-zero, following traffic"*
- Example: "*American 452, Turn left heading one-three-zero, join the localizer, cleared visual approach Runway one-zero, following traffic*"

[13] FAA JO 7110.65 para. 5-7-3 a. 2 states, *"A pilot will advise if unable to comply with the speed assignment"*.

- Example: *"American 452, heading one-three-zero to join the localizer, cleared visual approach Runway one-zero, follow traffic"*

CAS Instruction after the Approach Clearance

- ATC Message: "[CAS aircraft Flight ID] FOLLOW TRAFFIC"
- Example: "*American 452, follow traffic*"
- Flight Deck Message: "[CAS Aircraft Flight ID], FOLLOWING (or FOLLOW) TRAFFIC"
- Example: *"American 452, following traffic"*

**Note:** ATC and Flight Crews may optionally use the term "designated" when issuing or responding to the CAS Instruction for clarity or emphasis. (e.g., "…follow designated traffic.", "…following designated traffic."

**Note:** In the context of the CAS Instruction, "follow traffic" allows Flight Crews to transition through instrument meteorological conditions only when they have previously designated TTF and been issued an Instrument Approach clearance.

### 5.4.4 Abnormal Cancellation/Rejection of CAS

While rare, there may be times when the flight crew may reject a CAS instruction or may need to cancel an ongoing CAS operation. In addition, ATC may need to cancel an ongoing CAS operation due to operational needs. In either case, ATC will issue alternate control instructions. The sections below contain the phraseology to be used in these events.

#### 5.4.4.1 Rejection of CAS by the Flight Crew

Flight crews may reject a CAS instruction during the Traffic Identification phase or when the CAS instruction is issued. This may be due to flight crew prerogative or the inability of the avionics to display the TTF in the MCDU.

- ATC Message: "[CAS aircraft Flight ID] DESIGNATE [TTF Flight ID]"
- Example: "*American 452, Designate Southwest 387*"
- Flight Deck Message: "UNABLE, [CAS aircraft Flight ID]"
- Example: "*Unable, American 452*"
- ATC Message: "[CAS aircraft Flight ID], [Alternate Control Instructions]"
- ATC Example: *"American 452, Roger, Maintain 190 knots"*

#### 5.4.4.2 Abnormal Cancellation of CAS by the Flight Crew

After the initiation of the CAS operation, the flight crew may report that they are unable to continue with the operation or avionics failure. The flight crew may optionally communicate the reason. ATC will then issue alternate control instructions.

- Flight Deck Message: "UNABLE TO FOLLOW DESIGNATED TRAFFIC [Optional Reason] [CAS aircraft Flight ID],"

- Example: *"Unable to Follow Designated Traffic, Traffic Lost, American 452"*
- ATC Message: "[CAS aircraft Flight ID], [Alternate Control Instructions]"
- Example: "*American 452, Reduce to final approach speed"*

#### 5.4.4.3 Abnormal Cancellation of CAS by ATC

If ATC has a need to cancel an ongoing CAS operation, they will issue the cancellation instruction and alternate control instructions.

- ATC Message: "[CAS aircraft Flight ID], DISREGARD DESIGNATED TRAFFIC, [Alternate Control Instructions]"
- Example: "*American 452, Disregard Designated Traffic, Reduce Speed to 170"*

## 5.5 Sample Scenario

### 5.5.1 Overview Figure of CAS

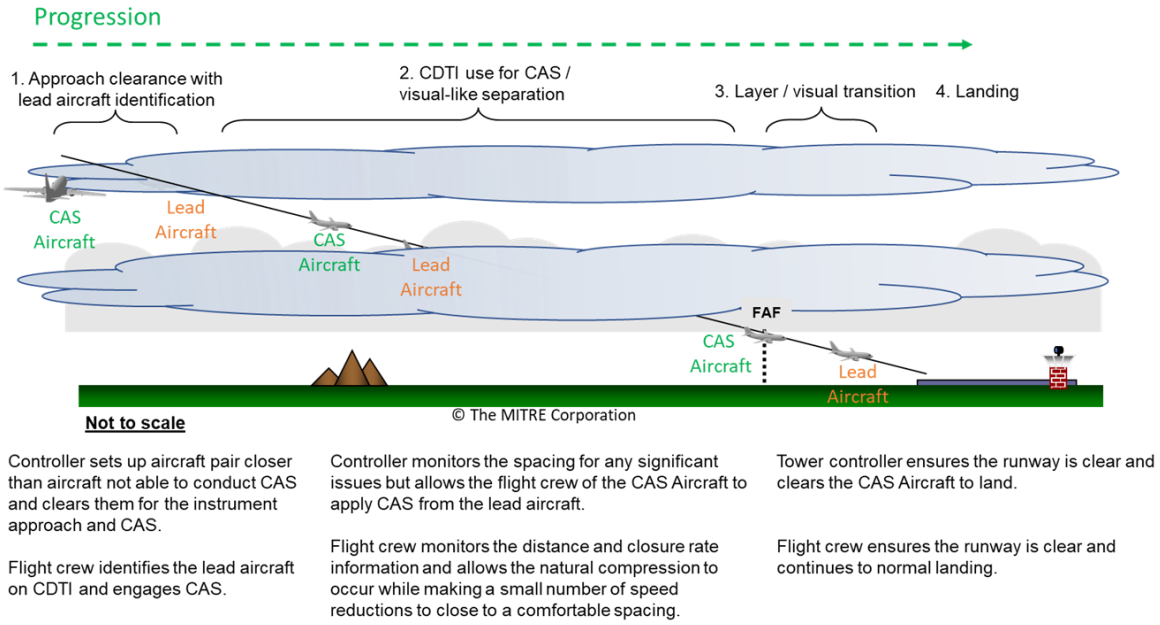


*Figure 5-5 - Sample CAS Operation*

### 5.5.2 Detailed Instrument Approach Scenario

The following example describes the CAS procedure as it may be applied at Airtown (KAIR) airport on runway 16. In this sample scenario, AAL452 and SWA387 are the aircraft arriving for the approach. AAL452 is an Airbus A321 and SWA387 is a Boeing B737. AAL452 is equipped with the necessary equipment for CAS. AAL452 is arriving from the southwest and is descending via an Optimized Profile Descent (OPD) arrival. SWA387 is arriving from the

southeast and is being vectored. The weather conditions are a cloud layer with tops at 15,000 feet and bases at 1,700 feet with four miles visibility below 1,700 feet. The surface winds are from 190 degrees at 10 knots (Figure 5-6). The scenario will be narrated from the perspective of the flight crew of AAL452.

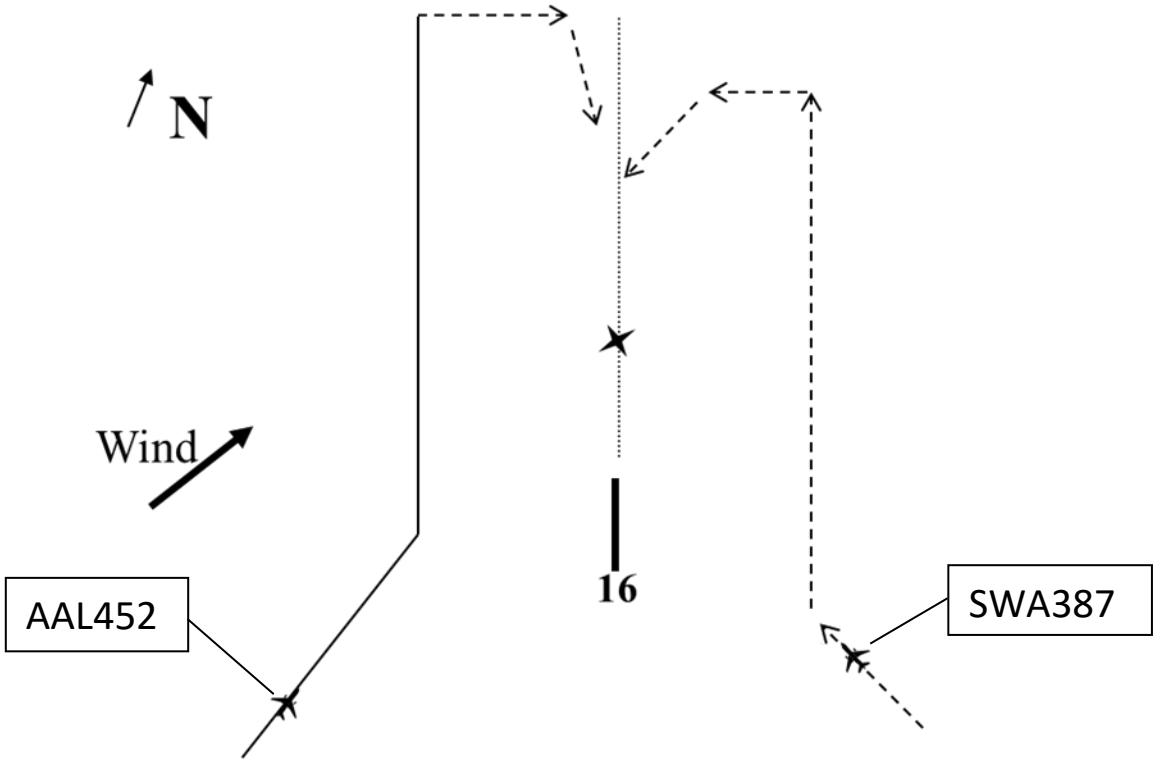


*Figure 5-6 - Sample Scenario Instrument Arrival Plan View*

Prior to arriving in the KAIR area, both flight crews are notified by the KAIR Automated Terminal Information System (ATIS) that Instrument Landing System (ILS) operations are being conducted. The flight crew of AAL452 brief the ILS approach.

As AAL452 and SWA387 approach the terminal area, the center executes the hand-offs and instructs the flight crews to contact approach control. The aircraft then check in on the assigned frequency with approach control. Having determined that SWA387 will lead AAL452, the feeder controllers will instruct SWA387 and AAL452 to expect the ILS approach.

- SWA387: "*Airtown Approach, Southwest three-eighty-seven at one zero thousand with Delta.*"
- East Feeder Controller: "*Southwest three-eighty-seven, Airtown Approach. Descend and maintain five thousand. Expect ILS runway one six.*"
- SWA387: "*Southwest three-eighty-seven, leaving one zero thousand for five thousand. Expect ILS runway one six.*"

AAL452 also checks in with Airtown approach control.

- AAL452: "*Airtown Approach, American four-fifty-two, leaving one-one thousand descending via TOJOE One with information Delta*."
- West Feeder Controller: "*American four-fifty-two, Airtown Approach. Expect ILS runway one six*."
- AAL452: "*American four-fifty-two. Expect ILS runway one six.*"

The feeder controllers issue vectors and speed instructions, as necessary, to SWA387 and monitors AAL452 as it flies the OPD. The feeder controllers hand off the aircraft to the approach control final controller and instructs the flight crews to contact the final controller. At this point, the flight crews have determined their final approach speeds. AAL452 and SWA387 are 145 and 135 knots, respectively.

Upon check in, the final controller advises AAL452 to designate SWA387 for the CAS operation.

- Final Controller: "*American four-fifty-two. Designate Southwest three-eighty-seven.*"

At this point, the flight crew[14] of AAL452 searches for, identifies, and designates SWA387 on their displays in anticipation of applying CAS during the ILS approach. Once the aircraft is designated, additional information is provided on the CDTI to the flight crew. This information includes SWA387's ground speed, range, ground speed differential and flight identification (see Figure 5-7). The flight crew then advises ATC of the designation of the traffic to follow.

- AAL452: "*American four-fifty-two has designated Southwest three-eighty-seven*."

[14] The Flight ID will be entered by either the pilot flying or the pilot monitoring, depending on workload. The pilot flying and pilot monitoring will cross-verify the Flight ID. The confirmation of the Flight ID to air traffic control will be done through a readback from the MCDU or AGD.


*Figure 5-7 - Sample CDTI Showing Selected Aircraft Information*

As AAL452 exits the OPD from the downwind, the final controller issues altitude and heading instructions to both aircraft as necessary to get them into position for the approach. During this time, the flight crew of AAL452 continues to track SWA387 on the CDTI, and controllers continue to provide standard radar separation.

The following communications then occur prior to intercepting final.

- Final Controller: "*Southwest three-eighty-seven, eight miles from FFAFF. Turn left heading one nine zero. Maintain four thousand until established on the localizer. Cleared ILS runway one six*."
- Flight crew SWA387: "*Southwest three-eighty-seven, left heading one nine zero. Maintain four thousand until established. Cleared ILS one six*."
- Final Controller: "*Southwest three-eighty-seven, maintain one seven zero knots until FFAFF. Contact tower at FFAFF*."
- Flight crew SWA387: "*Southwest three-eighty-seven, Maintain one seventy until FFAFF. Contact tower at FFAFF*."

After SWA387 has been cleared for the ILS to runway 16, the flight crew will conduct the approach to end with a normal landing.

The final controller has anticipated CAS, so AAL452 is being vectored to enable a reduced spacing, as compared to non-visual separation operations, when joining final approach.

The final controller provides the CAS instruction and ILS clearance.

- Final Controller: "*American four-fifty-two, seven miles from FFAFF, turn right heading one three zero, maintain four thousand until established on the localizer, cleared ILS*

*runway one six. Maintain one seven zero knots or greater to the marker. Follow designated traffic*."

- Flight crew AAL452: "*American four-fifty-two, heading one three zero, maintain four thousand until established, cleared ILS approach runway one six. One seven zero knots or greater to the marker. Following Traffic*."

Since the flight crew of AAL452 has already designated SWA387, the traffic symbol for SWA387 shows as designated and the "Traffic Range" advisory is active based on the default minimum range. Company procedures define this as the minimum value, but the flight crew can adjust if desired. This provides the flight crew with range awareness information that may require subsequent action. In addition to the information shown when SWA387 was designated, differential ground speed is displayed on the CDTI. The flight crew of AAL452 is now authorized to use the CDTI information to perform CAS on SWA387. They follow the speed instruction issued by the controller unless the issued speed interferes with the flight crew's ability to follow or maintain safety of flight. If the flight crew cannot maintain the speed issued by the controller, they will advise ATC.

After AAL452 intercepts the localizer behind SWA387, the flight crew views the information on SWA387 and notices that it is 4.2 miles ahead and the differential ground speed +30 knots. SWA387 was given a speed of 170 knots to the FAF, and AAL452 is still flying 210 knots since ATC asked them to maintain 170 knots or greater to the marker.

With about eight miles to the Final Approach Fix (FAF) and 4.2 miles in trail of SWA387, the flight crew of AAL452 elects to maintain their present speed of 210 knots for the time being. In a little over two minutes, they will reach the FAF and would gain about a mile on SWA387 with the current differential ground speed. Anticipating that SWA387 will start decelerating at the FAF, the crew plans to decelerate at the normal point to reach the FAF at about 180 knots. For the A321, they have determined that a good rule of thumb is to lose 10 knots for every mile in level flight at idle thrust. They determine that this should put them just inside of three miles in trail of SWA387 when they reach the FAF. With normal deceleration to final approach speed, they will be slightly over two miles in trail when SWA387 reaches the threshold. This has been observed as a good average target that gives adequate time for SWA387 to clear the runway under normal conditions. Figure 5-8 shows the CDTI as the operation progresses when both aircraft are on final approach.


*Figure 5-8 – Sample CDTI During CAS Operation*

As the approach continues, the flight crew of AAL452 monitors the spacing from SWA387 until it exits the cloud layer just outside the FAF. At this point, SWA387 can be seen visually (but with some difficulty) as depicted in Figure 5-9.

*Figure 5-9 - Visual Scene for AAL452*

The flight crew continues to use the CAS information provided on the CDTI, but may also track the aircraft visually OTW. As the airport comes into sight, the flight crew continues its visual scan keeping SWA387 and the airport (or the runway) in sight. As SWA387 touches down, AAL452 is about 2.3 miles in trail, comfortably in position to make a normal landing. AAL452 flight crew visually monitors the runway environment OTW and on the CDTI. As SWA387 lands and exits the runway, the tower controller ensures the runway is vacant and clears AAL452

for landing[15]. The flight crew watches SWA387's traffic symbol change from green to brown once it lands. The flight crew also sees the point of the traffic symbol chevron indicate SWA387 has turned to exit the runway. The flight crew visually ensures that SWA387 is clear and continues to a normal landing.

### 5.5.3 Detailed Visual Approach Scenario

The following example describes the CAS procedure during visual operations at Airtown on runway 16. In this sample scenario, AAL452 and SWA387 are again the aircraft arriving for the visual approach. AAL452 is a CAS equipped Airbus A321 and SWA387 is a Boeing 737. AAL452 is arriving from the southwest and is descending via an Optimized Profile Descent (OPD) arrival. SWA387 is arriving from the southeast and is being vectored. The weather conditions are a cloud layer with tops at 15,000 feet and bases at 8,000 feet with seven miles visibility. The surface winds are from 190 degrees at 10 knots (see Figure 5-10). The scenario will be narrated from the perspective of the flight crew of AAL452 and feeder controllers.

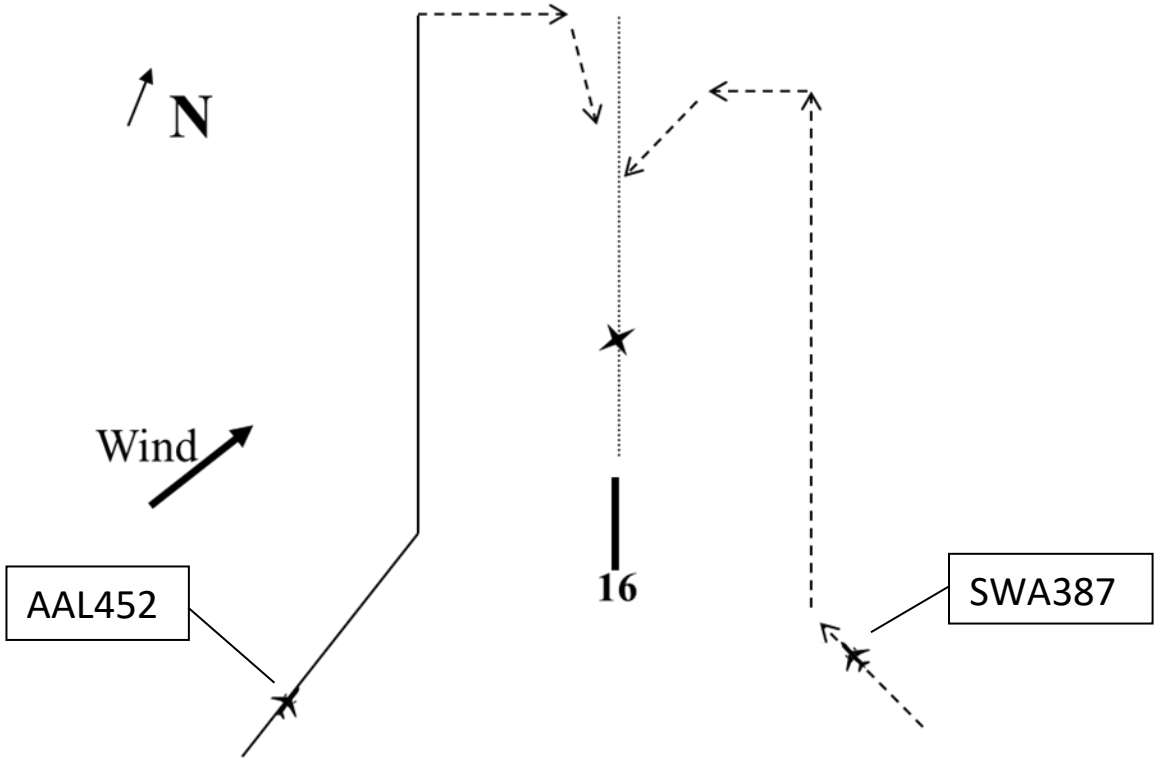


*Figure 5-10 Sample Scenario Visual Arrival Plan View*

Prior to arriving in the KAIR area, both flight crews are notified by the KAIR Automated Terminal Information System (ATIS) that Visual Approach operations are being conducted. The flight crew of AAL452 briefs the visual approach.

[15] This clearance to land could have occurred earlier on final approach (e.g., outside the FAF).

As AAL452 and SWA387 approach the terminal area, the center executes the hand-offs and instructs the flight crews to contact approach control. The aircraft then check in on the assigned frequency with approach control. Having determined that SWA387 will lead AAL452, the feeder controllers will instruct SWA387 to report the airport in sight. AAL452 need not report the airport in sight because they will be using CAS.

- SWA387: "*Airtown Approach, Southwest three-eighty-seven at one zero thousand with Delta.*"
- East Feeder Controller: "*Southwest three-eighty-seven, Airtown Approach. Descend and maintain five thousand. Expect Visual Approach runway one six, report the airport in sight.*"
- SWA387: "*Southwest three-eighty-seven, leaving one zero thousand for five thousand. Expect runway one six.*"

AAL452 also checks in with Airtown approach control.

- AAL452: "*Airtown Approach, American four-fifty-two, leaving one-one thousand descending via TOJOE One with information Delta*."
- West Feeder Controller: "*American four-fifty-two, Airtown Approach. Expect Visual Approach runway one six*"
- AAL452: "*American four-fifty-two. Expect runway one six.*"

The feeder controllers issue vectors and speed instructions, as necessary, to SWA387 and monitors AAL452 as it flies the OPD. The feeder controllers hand off the aircraft to the approach control final controller and instruct the flight crews to contact the final controller. At this point, the flight crews have determined their final approach speeds. AAL452 and SWA387 are 145 and 135 knots, respectively.

Upon check in, the final controller advises AAL452 to designate SWA387 for the CAS operation.

- Final Controller: "*American four-fifty-two. Designate Southwest three-eighty-seven.*"

At this point, the flight crew[16] of AAL452 searches for, identifies, and designates SWA387 on their displays in anticipation of applying CAS during the Visual approach. The flight crew then advises ATC of the identification of the traffic to follow.

- AAL452: "*American four-fifty-two has designated Southwest three-eighty-seven*."

As SWA387 gets closer to the airport, they establish visual contact with the airport, and report the airport in sight.

The following communications occur.

- Flight crew SWA387: "Southwest three-eighty-seven has the airport in sight."
- Final Controller: "Southwest three-eighty-seven, roger.

[16] The Flight ID will be entered by either the pilot flying or the pilot monitoring, depending on workload. The pilot flying and pilot monitoring will cross-verify the Flight ID. The confirmation of the Flight ID to air traffic control will be done through a readback from the MCDU or AGD.

As AAL452 exits the OPD from the downwind, the final controller issues altitude and heading instructions to both aircraft as necessary to get them into position for the approach. During this time, the flight crew of AAL452 continues to track SWA387 on the CDTI, and controllers continue to provide standard radar separation.

The following communications then occur prior to intercepting final.

- Final Controller: "*Southwest three-eighty-seven, four miles from FFAFF. Turn left heading one nine zero. Maintain three thousand until established on the localizer. Cleared Visual Approach runway one six*."
- Flight crew SWA387: "*Southwest three-eighty-seven, left heading one nine zero. Maintain three thousand until established. Cleared Visual Approach runway one six*."
- Final Controller: "*Southwest three-eighty-seven, maintain one seven zero knots until FFAFF. Contact tower at FFAFF*."
- Flight crew SWA387: "*Southwest three-eighty-seven, Maintain one seventy until FFAFF. Contact tower at FFAFF*."

After SWA387 has been cleared for the approach to runway 16, the flight crew will conduct the approach to end with a normal landing.

The final controller has anticipated CAS, so AAL452 is being vectored to enable a reduced spacing, as compared to non-visual separation operations, when joining final approach. When AAL452 is in the appropriate location, in this case where the aircraft is expected to be clear of clouds and vectored to intercept the final approach course, the visual approach clearance and the CAS instruction is issued.

The final controller provides the CAS instruction and visual approach clearance.

- Final Controller: "*American four-fifty-two, four miles from FFAFF, turn right heading one three zero, maintain three thousand until established on the localizer, cleared Visual Approach runway one six. Maintain one seven zero knots or greater to the marker. Follow designated traffic.*"
- Flight crew AAL452: "*American four-fifty-two, heading one three zero, maintain three thousand until established, cleared visual approach runway one six. One seven zero knots or greater to the marker. Following traffic*."

They follow the speed instruction issued by the controller unless the issued speed interferes with the flight crew's ability to follow preceding traffic. If the flight crew cannot maintain the speed issued by the controller, they will advise ATC.

After AAL452 intercepts the localizer behind SWA387, the flight crew views the information on SWA387 and notices that it is 3.25 miles ahead and the differential ground speed +10 knots. SWA387 was given a speed of 170 knots to the FAF, and AAL452 is still flying 170 knots since ATC instructed them to maintain 170 knots or greater to the marker.

Anticipating that SWA387 will start decelerating at the FAF, the crew also plans to decelerate at the FAF to final approach speed. With normal deceleration, they will be slightly over two miles in trail when SWA387 reaches the threshold. The flight crew continues to monitor the interval

between aircraft, and comfortable with the spacing, and adequate time for exists for SWA387 to clear the runway under normal conditions.

As the approach continues, the flight crew of AAL452 monitors the spacing from SWA387, SWA387 may be seen visually but this does not change the CAS operation.

The flight crew continues to use the CAS information provided on the CDTI but may also track the aircraft visually OTW. As the airport comes into sight, the flight crew continues its visual scan keeping SWA387 and the airport (or the runway) in sight. As SWA387 touches down, AAL452 is about 2.3 miles in trail, comfortably in position to make a normal landing. AAL452 flight crew visually monitors the runway environment OTW and on the CDTI. As SWA387 lands and exits the runway, the tower controller ensures the runway is vacant and clears AAL452 for landing[17]. The flight crew watches SWA387's traffic symbol change from green to brown once it lands. The flight crew also sees the point of the traffic symbol chevron indicate SWA387 has turned to exit the runway. The flight crew visually ensures that SWA387 is clear and continues to a normal landing.

## 5.6 Airspace Characteristics and Operational Environment

### 5.6.1 Airspace / Runway Characteristics

CAS is designed to be operationally approved in terminal airspace wherever instructions for maintaining pilot-applied visual separation for arriving aircraft are used.

ATC is provided by Approach Control and Tower Control services. Approach Control services are provided using radar, while Tower Control services are provided using visual contact with aircraft on final approach. Radar characteristics for Approach Control services are "as today" when instructions for maintaining visual separation are used (i.e., no specific requirements).

**NOTE**: Radar is not a minimum requirement for the provision of Tower Control services to be able to conduct CAS operations. Nevertheless, the Tower Controller may utilize radar at airports where it is available.

**NOTE**: CAS could also be applied in an environment where surveillance is achieved for the Approach Controller using other surveillance techniques than radar (e.g., multilateration). However, the assessment of CAS in this document is based on an Approach radar environment.

CAS is defined to use Very High Frequency (VHF) or ultra High Frequency (UHF) voice as the media for communications between controllers and flight crews. Controller Pilot Data Link Communication (CPDLC) may also be considered for future use but is not addressed in this document.

CAS can be applied in airspace of any traffic density.

CAS is applicable between the CAS aircraft and a single TTF approaching the same runway.

[17] This clearance to land could have occurred earlier on final approach (e.g., outside the FAF).

### 5.6.2 Meteorological Conditions

CAS can be conducted when the airport of intended landing has a reported ceiling of 1000 feet or greater and visibility of 3 SM or greater. The aircraft conducting a CAS operation may enter IMC conditions during flight unless the aircraft is on a visual approach clearance.

### 5.6.3 Flight-Deck Automatic Dependent Surveillance-Broadcast (ADS-B) Equipage

CAS operations use the same equipment meeting the requirements defined in TSO-C195b as that defined for the CAVS application. The TTF must have an ADS-B Out capability and broadcast ADS-B data meeting the CAVS requirements. The CAS Aircraft must be equipped with the avionics that meet the CAVS requirements[18].

### 5.6.4 Applicability Conditions

The applicability conditions of CAS are identical to the current applicability conditions for instructions to maintain visual separation from the TTF approaching the same runway (e.g., the CAS aircraft is not authorized to follow a Super category aircraft).

## 5.7 Abnormal Modes

While rare, there are conditions that may prevent the flight crew from continuing a CAS operation. Examples of these conditions include avionics issues, such as, loss of TTF ADS-B Out signal, loss of CAS Aircraft ADS-B In capability, avionics alert messages and situational issues, such as flight crew inability to sufficiently reduce airspeed to avoid an overtake event. When the flight crew is unable to continue with the CAS operation for any reason, they shall notify ATC, by stating “Unable to follow designated traffic”. ATC will then issue instructions to the flight crew, as appropriate. Should any situation occur that affects the safety of flight, such as a wake turbulence encounter or insufficient range behind the TTF, the flight crew will apply current day contingency procedures and advise ATC.

[18] Specific avionics requirements are contained in (DO-317B RTCA, Inc., 2014).

## Appendix A. Assumptions

This section extracts and lists the Assumptions from the previous chapters.

- The CAS aircraft shall be equipped with an avionics system meeting the requirements defined in TSO-C195b or later to support the CAVS application.
- CAS can be used by aircraft flying an instrument or visual approach at controlled airports.
- CAS does not change any requirements for flying instrument or visual approaches.
- CAS is applicable between the CAS aircraft and a single TTF approaching the same runway.
- Requirements for pilot-applied visual separation operations also apply in CAS operations (e.g., the CAS aircraft is not authorized to follow a Super category aircraft.)
- CAS can be conducted when the airport of intended landing has a reported ceiling of 1000 feet or greater and visibility of 3 SM or greater. The aircraft conducting a CAS operation while on an Instrument Approach may enter IMC conditions during flight.
- If the weather conditions deteriorate below the minima for the airport, the controller will suspend the use of CAS and apply another form of separation.
- CAS can be used by all suitably equipped aircraft during approach to any airports where instructions for maintaining pilot-applied visual separation from the TTF are used.
- CAS does not change any pilot and controller procedures related to wake vortex limitations or runway occupancy time.
- Abuse or intentional misuse of information provided to the flight crew, or the controller are out of the scope for the CAS assessment.
- CAS is defined to be used in Terminal Airspace to support aircraft performing approach and landing operations. Air Traffic Control is provided by Approach Control and Tower Control services as today (i.e., there are no specific requirements).
- As in current operations, Tower and Approach Controllers shall issue clearances, instructions, safety alerts, and traffic advisories according to facility requirements and standard operating procedures.
- Approach Control services are provided using radar.
- Radar is not a minimum requirement for the provision of Tower Control services to be able to conduct CAS operations.

  **NOTE**: The Tower Controller may utilize radar at airports where it is available.
- The airspace in which CAS is used has VHF or UHF voice as means of communications between controllers and flight crews.
- For the traffic advisory, controllers will use the Flight ID of the TTF when identifying that aircraft.
- CAS can be applied in airspace of any traffic density.

- The ADS-B equipage (i.e., ADS-B Out and ADS-B In) within the deployment environment will be mixed.
- The roles and responsibilities of the controller related to visual separation instructions are unchanged.
- Air Traffic Controllers will be trained in CAS procedures prior to use.
- Flight Crews will be trained in CAS procedures and avionics prior to use.

## Appendix B. Phase Tables

Tables associated with the Phase Diagrams modelling the various phases are shown in this appendix.

The following convention is used to indicate who or what is responsible for the task:

- GND-Pro = A task performed specifically by the ground processing equipment
- GND-ATCo = A task performed specifically by the Air Traffic Controller
- GND = A task performed either by ground processing equipment or by Air Traffic Controller or by a combination of both
- AC-Av = A task performed specifically by the aircraft avionics
- AC-FC = A task performed specifically by the aircraft flight crew
- AC = A task performed either by the aircraft avionics or by the flight crew or by a combination of both

The list of required Information on Ground (IG) which must be available for display to the controller is:

- IG01 – CAS aircraft flight ID
- IG02 – General traffic situation
- IG03 – TTF and CAS Aircraft horizontal position (to assess applicability conditions)
- IG04 – TTF and CAS Aircraft altitude (to assess applicability conditions)
- IG05 – TTF and CAS Aircraft direction (to assess applicability conditions)
- IG06 – TTF and CAS Aircraft ground speed (to assess applicability conditions)
- IG07 – TTF and CAS Aircraft type (to be used in the traffic information by the controller and to address configurations subject to wake turbulence)
- IG08 – TTF airline if available (to be used in the traffic information by the controller)

**NOTE**: The aircraft airline is usually available to the controller through the means of the callsign. If the aircraft has no airline, then the flight ID is the aircraft registration, and it is not used in the traffic information.

**NOTE**: The controller needs IG01 to IG08 to assess the applicability of a CAS instruction.

**NOTE**: The requirements for IG01 to IG08 are not changed from today's operations.

The following information should be available for display to the controller:

- IG09 – CAS equipage status

The controller must know:

- IG10 – Airport cloud base and visibility
- IG11 – TTF flight ID

The list of required Information in Air (IA) which must be available to the Receive Aircraft Domain flight crew (for all ADS-B Out equipped traffic except when specified differently in the tables below) is:

- IA01 – Relative horizontal position (i.e., range and relative bearing)
- IA02 – Altitude (Relative altitude required. Barometric corrected pressure altitude and absolute pressure altitude are optional.)
- IA03 – Flight ID
- IA04 – Ground track
- IA05 – Vertical tendency
- IA06 – Qualification status for CAS
- IA07 – OTW information on the TTF
- IA08 – TTF flight ID received from the controller
- IA09 – Ground speed information related to the TTF

**NOTE**: The differential ground speed must be displayed at the minimum when the CAS Aircraft and the TTF are in-trail of each other, defined when the relative track angle between the aircraft is less than 20 degrees. Both the CAS Aircraft and TTF ground speeds must be continuously displayed.

- IA11 – Digital read-out of the horizontal range to the TTF

**NOTE**: The differential ground speed and the horizontal range must be displayed in the Forward Field of View.

- IA12 – Advisory indicating that the TTF is no longer qualified to support CAS
- IA13 – Traffic Range Alert indicating that the horizontal range to the TTF falls below a value selected by the flight crew. It is an advisory level alert.
- IA14 – Traffic Minimum Range Caution indicating that the CDTI can no longer be used without OTW visual contact

| **Phase 1 – TTF Identification** |
|---|
| **Objective** – The controller provides the TTF flight ID to the flight crew of the CAS aircraft for identification. The flight crew looks at the CDTI to detect then designate the TTF. After having designated the TTF, the flight crew reports designation to the controller. If identification or designation is not achieved, the flight crew informs the controller, continues the CDTI search and reports to the controller when designation is eventually achieved. |

*Table B-1- TTF Identification Phase (Controller Initiative)*

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 1.1 | Assess applicability conditions for instruction to maintain CAS from the TTF on approach | GND-ATCo | IG01 – CAS aircraft flight ID<br>IG02 – General traffic situation<br>IG03 – TTF and CAS Aircraft horizontal position<br>IG04 – TTF and CAS Aircraft altitude<br>IG05 – TTF and CAS Aircraft direction<br>IG06 – TTF and CAS Aircraft ground speed<br>IG09 – CAS equipage status if available<br>IG10 – Airport cloud base and visibility<br>IG11 – TTF flight ID | Applicability conditions satisfied | 1.2 |
| | | | | Applicability conditions not satisfied | 4.2 |
| 1.2 | Provide TTF information to the CAS Aircraft | GND-ATCo<br>→<br>AC-FC | IG01 – CAS aircraft flight ID<br>IG07 – TTF and CAS Aircraft type<br>IG11 – TTF flight ID<br>(optionally IG3, IG4, IG5, IG6, and IG8) | Information provided | 1.3 |

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 1.3 | Designate TTF on CDTI using flight ID, and any other information, provided by the controller | AC-FC | IA01 – Relative horizontal position (all displayed ADS-B traffic)<br>IA02 – Altitude (all displayed ADS-B traffic)<br>IA03 – Flight ID (all displayed ADS-B traffic)<br>IA04 – Ground track (all displayed ADS-B traffic)<br>IA05 – Vertical tendency (all displayed ADS-B traffic)<br>IA06 – Qualification status for CAS (traffic corresponding to TTF)<br>IA08 – TTF flight ID received from the controller | TTF identified and designated | 1.7 |
| | | | | TTF not identified, and additional time needed | 1.4 |
| | | | | TTF not identified, and lead is in question | 1.5 |
| 1.4 | Report “Looking” or “Negative contact” | AC-FC → GND-ATCo | - | Communication occurred | 1.6 |
| 1.5 | Confirm TTF flight ID with ATC | AC-FC → GND-ATCo | IA08 – TTF flight ID received from the controller | Communication occurred | 1.6 |

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 1.6 | Search for TTF on CDTI using flight ID, and any other information, provided by the controller | | IA01 – Relative horizontal position (all displayed ADS-B traffic)<br>IA02 – Altitude (all displayed ADS-B traffic)<br>IA03 – Flight ID (all displayed ADS-B traffic)<br>IA04 – Ground track (all displayed ADS-B traffic)<br>IA05 – Vertical tendency (all displayed ADS-B traffic)<br>IA06 – Qualification status for CAS (traffic corresponding to TTF)<br>IA08 – TTF flight ID received from the controller | TTF identified and designated | 1.7 |
| 1.7 | Report TTF designated | AC-FC<br>→<br>GND-ATCo | - | Communication occurred | 1.8 |

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 1.8 | Re-assess applicability conditions if necessary | GND-ATCo | IG01 – CAS aircraft flight ID<br>IG02 – General traffic situation<br>IG03 – TTF and CAS Aircraft horizontal position<br>IG04 – TTF and CAS Aircraft altitude<br>IG05 – TTF and CAS Aircraft direction<br>IG06 – TTF and CAS Aircraft ground speed<br>IG10 – Airport cloud base and visibility<br>IG11 – TTF flight ID | Applicability conditions satisfied | 2.1 |
| | | | | Applicability conditions not satisfied | 4.2 |

| **Phase 2 – Instruction for maintaining CAS from the TTF** |
|---|
| **Objective** – The controller issues the instruction for maintaining CAS from the TTF. The flight crew designates the traffic on the CDTI corresponding to the TTF, and either accepts or refuses the instruction. |

*Table B-2 - Instruction for Maintaining CAS from the TTF Phase*

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 2.1 | Instruct the CAS aircraft to conduct CAS from the TTF | GND-ATCo → AC-FC | IG01 – CAS aircraft flight ID | Communication occurred | 2.2 |
| 2.2 | Confirm designation of the TTF for CAS | AC-FC | IA01 – Relative horizontal position (traffic corresponding to TTF)<br>IA02 – Altitude (traffic corresponding to TTF)<br>IA04 – Ground track (traffic corresponding to TTF)<br>IA05 – Vertical tendency (traffic corresponding to TTF)<br>IA08 – TTF flight ID received from the controller | Designation confirmed | 2.3 |

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 2.3 | Decide ability to execute the CAS instruction | AC-FC | IA01 – Relative horizontal position (TTF)<br>IA02 – Altitude (designated traffic)<br>IA04 – Ground track (TTF)<br>IA05 – Vertical tendency (TTF)<br>IA08 –TTF flight ID received from the controller<br>IA09 –Ground speed information related to the TTF<br>IA11 – Digital read-out of the horizontal range to the TTF<br>Other information not related to traffic situation (e.g., meteorological conditions, workload, trainee pilot, etc.) | Able | 2.4 |
| | | | | Unable | 4.3 |
| 2.4 | Report ability to execute CAS instruction | AC-FC<br>→<br>GND-ATCo | - | Communication occurred | 2.5 |
| 2.5 | Confirm Traffic Range Alert threshold value | AC-FC | | Confirmed | 3.1 |

| **Phase 3 – Maintaining CAS on the approach** |
|---|
| **Objective** – The flight crew flies the approach while maintaining CAS from the TTF. |

*Table B-3 - Maintaining CAS on the Approach Phase*

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| 3.1 | Look at the TTF information on the CDTI (and OTW if available) | AC-FC | IA01 – Relative horizontal position (TTF)<br>IA02 – Altitude (TTF)<br>IA04 – Ground track (TTF)<br>IA07 – OTW information on the TTF<br>IA09 – Ground speed information related to the TTF<br>IA11 – Digital read-out of the horizontal range to the TTF<br>IA12 – Advisory alert indicating that the TTF is no longer qualified to support CAS<br>IA14 – Traffic Minimum Range Caution | Landing of TTF | 4.1 |
| | | | | Traffic Lost advisory on TTF | 4.3 |
| 3.2 | Assess if a speed change is required using CDTI | AC-FC | | No required speed change | 3.1 |
| | | | | Required speed change | 3.3 |

| ID | Description | Domain | Information Needed | Conditions for Transfer to Next Action | Next |
|---|---|---|---|---|---|
| | (supplemented with OTW information if available and desired) | | IA01 – Relative horizontal position (TTF)<br>IA02 – Altitude (TTF)<br>IA04 – Ground track (TTF)<br>IA07 – OTW information on the TTF<br>IA09 –Ground speed information related to the TTF<br>IA11 – Digital read-out of the horizontal range to the TTF<br>IA13 – Traffic Range Alert | Speed change insufficient / infeasible and too close to TTF | 4.3 |
| 3.3 | Request speed change approval from ATC if necessary | | - | Communication occurred and approved | 3.4 |
| 3.4 | Change speed to maintain CAS from the TTF | AC-FC | - | Speed change made | 3.1 |
| 3.5 | Monitor for Traffic Range Alert on TTF | AC-FC | IA13 – Traffic Range Alert | Alerted | 3.2 |
| 3.6 | Monitor for Traffic Minimum Range Caution on TTF & other CAS or system alerts leading to CAS system failure | AC-FC | IA14 – Traffic Minimum Range Caution | Alerted | 4.3 |

# Appendix C. Definitions

*Table C-1 - Definitions*

| Term | Alert Definitions |
|---|---|
| **Alert** | A generic term used to describe a flight deck indication meant to attract the attention of and identify to the flight crew a non-normal operational or airplane system condition. Alerts are classified at levels or categories corresponding to Warnings, Cautions, and Advisories. Alert indications also include non-normal range markings (e.g., exceedances on instruments and gauges.) |
| **Advisory Alert** | The level or category of alert for conditions that require flight crew awareness and may require subsequent flight crew response. |
| **Caution Alert** | The level or category of alert for conditions that require immediate flight crew awareness and a less urgent subsequent flight crew response than a warning alert. |
| **Warning Alert** | The level or category of alert for conditions that require immediate flight crew awareness and immediate flight crew response. |
| **Term** | **Definition** |
| **Flight ID** | Also known as “call sign”, combining the ICAO airline designator (and telephony) with the flight number to derive the Flight ID, such as “American Four Fifty-Six” for AAL456. |
| **Traffic-To-Follow** | The aircraft to be acquired and designated via the CDTI and from which the flight crew of the CAS Aircraft is instructed to follow. |
| **Designated traffic** | The traffic designated by the flight crew on the CDTI that they identify as being the TTF. |
| **Horizontal range** | Direct horizontal distance between the CAS Aircraft and the designated traffic. |
| **Pilot Applied Separation** | A term used to describe separation provided by the flight crew visually and during CAS operations. |

## Appendix D. Acronyms

*Table D-1 - Acronyms*

| | |
|---|---|
| **ADS-B** | Automatic Dependent Surveillance-Broadcast |
| **ASSAP** | Airborne Surveillance and Separation Assistance Processing |
| **ATC** | Air Traffic Control |
| **ATIS** | Automated Terminal Information Service |
| **CAS** | CDTI Assisted Separation |
| **CAVS** | CDTI Assisted Visual Separation |
| **CDTI** | Cockpit Display of Traffic Information |
| **FAF** | Final Approach Fix |
| **ft** | feet |
| **ILS** | Instrument Landing System |
| **IMC** | Instrument Meteorological Conditions |
| **MVA** | Minimum Vectoring Altitude |
| **NM** | Nautical Mile |
| **OPD** | Optimized Profile Descent |
| **OTW** | Out-The-Window |
| **SM** | Statute Mile |
| **TTF** | Traffic-to-Follow |
| **VMC** | Visual Meteorological Conditions |

## Appendix E. Trial Site

The following items will be covered in this section of the document:

- Trial Site Selection Process
  - Criteria
- DFW Runway Configurations, Airport Layout and Operations
- D10 Specific Scenario
  - Widely Spaced Independent Approaches
  - Visual Approaches
- Avionics Equipage Indication

## Trial Site Selection Process

In early 2020, an effort was undertaken to identify a trial site for CAS Approaches. A set of criteria was developed to maximize the opportunity for CAS use, facility acceptability.

## Criteria

- AAL Hub
- Sufficient Equipped Aircraft
- Sufficient Weather-Related Opportunity
    - e.g., VMC, but not conductive to Visual Approach operations
- Facility Acceptance
- Determine Available Operations
    - Arrivals
    - Departures
    - Parallel Arrivals
- Operational Constraints
    - Crossing Runways
    - Taxiway Configuration
    - Arrival/Departure Runways
- Lack of Competing FAA Programs

After initial analysis of American Airlines hubs, several airports were excluded from additional analysis due to either operational factors (e.g., lack of dedicated arrival runways) or competing FAA programs.

Using Aviation Systems Performance Metrics (ASPM) data for the remaining candidate sites, an evaluation was conducted that examined the number of ACSS avionics equipped aircraft and weather conditions that would support CAS usage. Determining the number of equipped aircraft was a straightforward process of counting the historic number of AAL A321 aircraft operating at each of the sites.

Since CAS is restricted to VMC and High VMC would allow for traditional visual approaches with pilot-applied visual separation, a weather condition known as Mixed Meteorological Conditions (MMC) was used to determine how many equipped aircraft could potentially benefit from CAS. ASPM lists ceiling and visibility conditions for MMC, but due to some unrealistically low visibility values, an additional set of filters was used for visibility. This analysis produced metrics indicating what percentage of operations and how many of the arrivals could potentially be issued a CAS instruction. The results are contained in Table E-1 - CAS Opportunity Analysis.

After lengthy discussions within the FAA, both at the headquarters level and with the candidate Terminal Radar Approach Control (TRACON) facilities it was determined that Dallas-Fort Worth TRACON (D10) would be the CAS trial site.

*Table E-1 - CAS Opportunity Analysis*

| CAS Opportunities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MMC Weather & American Airlines A321/A21N | | | | | | | | AAL Hub | | |
| Facility | ASPM Wx Weighted | Frequency | | Facility | CAS Wx Weighted 6 NM | Frequency | | Facility | CAS Wx Weighted 10 NM | Frequency |
| CLT | 1.69% | 1 Out of 59 | | CLT | 2.39% | 1 Out of 42 | 1 | CLT | 4.39% | 1 Out of 23 |
| DFW | 1.55% | 1 Out of 64 | | PHL | 1.99% | 1 Out of 50 | 2 | PHL | 4.21% | 1 Out of 24 |
| PHL | 1.03% | 1 Out of 97 | | LAX | 1.90% | 1 Out of 53 | 3 | MIA | 3.41% | 1 Out of 29 |
| LAX | 0.96% | 1 Out of 104 | | DFW | 1.66% | 1 Out of 60 | 4 | LAX | 3.14% | 1 Out of 32 |
| SFO | 0.87% | 1 Out of 115 | | SAN | 1.06% | 1 Out of 94 | 5 | DFW | 2.38% | 1 Out of 42 |
| SAN | 0.79% | 1 Out of 126 | | SFO | 0.87% | 1 Out of 115 | 6 | MCO | 2.11% | 1 Out of 47 |
| SEA | 0.57% | 1 Out of 175 | | SEA | 0.62% | 1 Out of 161 | 7 | SAN | 2.02% | 1 Out of 49 |
| LGA | 0.33% | 1 Out of 307 | | LGA | 0.61% | 1 Out of 165 | 8 | SFO | 1.41% | 1 Out of 71 |
| MIA | 0.28% | 1 Out of 361 | | MCO | 0.49% | 1 Out of 204 | 9 | LGA | 1.15% | 1 Out of 87 |
| FLL | 0.26% | 1 Out of 387 | | JFK | 0.48% | 1 Out of 207 | 10 | JFK | 1.12% | 1 Out of 89 |
| BOS | 0.24% | 1 Out of 419 | | BOS | 0.46% | 1 Out of 219 | 11 | ORD | 0.91% | 1 Out of 110 |
| MCO | 0.23% | 1 Out of 429 | | ORD | 0.44% | 1 Out of 229 | 12 | TPA | 0.91% | 1 Out of 110 |
| DCA | 0.23% | 1 Out of 430 | | DCA | 0.38% | 1 Out of 260 | 13 | BOS | 0.84% | 1 Out of 119 |
| JFK | 0.23% | 1 Out of 433 | | MIA | 0.36% | 1 Out of 274 | 14 | DCA | 0.82% | 1 Out of 121 |
| ORD | 0.21% | 1 Out of 466 | | TPA | 0.31% | 1 Out of 324 | 15 | SEA | 0.72% | 1 Out of 138 |
| PHX | 0.12% | 1 Out of 832 | | FLL | 0.27% | 1 Out of 376 | 16 | BWI | 0.33% | 1 Out of 302 |

## DFW Runway Configurations and Operations

DFW consists of seven runways with five of them being North/South parallel runways. There are many different runway configurations used at DFW, but there are only a few that make up the bulk of the operations. DFW operates in either a North or South operation, with the departure and arrival runways depicted in Table E-2 - DFW Runway Configurations below.

*Table E-2 - DFW Runway Configurations*

| Op | Arrival Runways | Departure Runways | Number of Hours | Percent of Hours |
|---|---|---|---|---|
| South | 13R, 17C, 17L, 18R | 17R, 18L | 4,763 | 54% |
| North | 31R, 35C, 35R, 36L | 31L, 35L, 36R | 1,121 | 13% |
| South | 13R, 17L, 18R | 17R, 18L | 762 | 9% |
| North | 31R, 35R, 36L | 31L, 35L, 36R | 544 | 6% |

*Source: ASPM - Calendar Year 2019*

D10 primarily uses Visual Approaches when weather conditions permit, which is estimated to be approximately 75% of the time. The remaining 25% of the time, D10 uses Instrument Approaches either due to IMC weather at the airport or VMC with visibility or ceiling values being too low to efficiently run Visual Approaches. Those times of Instrument Approaches during VMC weather are considered the benefit pool for CAS.

## Widely Spaced Independent Approaches

The following scenario will describe CAS operations to Runways 18R and 17L with Instrument Approaches in use. These runways are 13,800 feet apart which allows D10 to run parallel runway operations without the use of Final Monitors[19]. The scenario will consist of four CAS equipped aircraft with two each controlled by the West Side Final Controller (AR3) and the East Side Final Controller (AR1). For ease of comprehension, the scenario will follow each of the Final sectors in chronological order. Figure E 1 illustrates the starting position of each of the aircraft when the scenario begins. A summary of actions taken prior to the start of the scenario will begin each section.

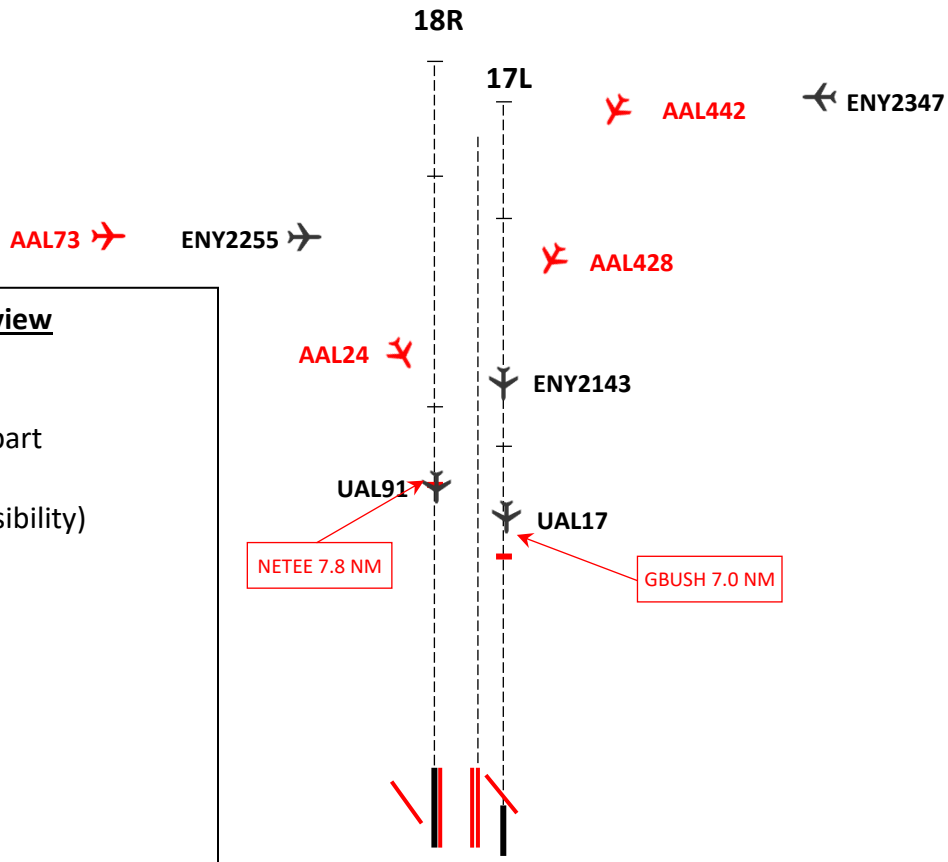


*Figure E-1 - Diagram of Widely Spaced Independent Approach Operations*

**Scenario Operational Overview**

- Runways 18R & 17L
  - Centerlines are 13,800 ft. apart
- Wx @ DFW – Low VMC
  - VMC (1200' Ceiling/4NM Visibility)
  - Winds 200° @ 10 Knots
- Two final positions are staffed
  - Per 7110.65 reqs.
- Intercept Altitudes
  - 18R @ 3000'
  - 17L @ 4000'
- 30° Intercept Headings to Final
  - FAF 18R – NETEE @ 7.8NM
  - FAF 17L – GBUSH @ 7NM
- Reduction to 190K required 5NM from Final
- Feeder controllers issue approach to expect
- Feeder controllers also issue:
  - 210K and descending to 5000' for AR3
  - 210K and descending to 6000' for AR1
- In the diagram, runways in black are arrival runways and runways in red are for departures

[19] FAA JO 7110.65 para. 5-9-10 *Simultaneous Independent Approaches To Widely-Spaced Parallel Runways Without Final Monitors*

## AR3 Runway 18R Initial Setup

AR3 recognized that AAL24 was CAS equipped and, due to smaller spacing needed inside the FAF, initially told the aircraft to maintain 210K to compress the spacing behind UAL91.

- **AR3**: "*AAL24, Maintain 210 knots, Designate UAL91.*"

AAL24 searches for, identifies and designates UAL91. Once designated, the AGD displays additional information, allowing the flight crew to observe the range, ground speed, differential ground speed and fight ID of UAL 91.

- **AAL24**: "*AAL24 has designated UAL91*"

As AAL24 approaches 5 NM from the localizer, AR3 reduces their airspeed to 190 knots, as per the D10 SOP. AR3 then turned UAL91 to a 150° heading and cleared the aircraft for the ILS18R approach and to maintain 170 knots or greater to the FAF. AAL24 is turned to a 150° heading, told to join the localizer and to maintain 190 knots until advised.

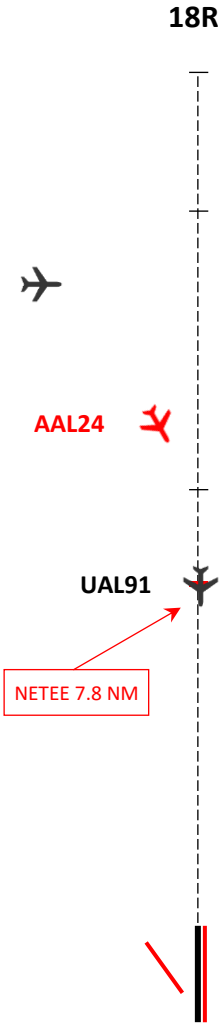


*Figure E-2 - AR3 Runway 18R Initial Setup*

## AR3 Runway 18R Remaining Actions

AR3 observes that the spacing between AAL24 and UAL91 is at 3.3 NM, which will allow compression to further reduce the spacing to approximately 2.5 NM on short final. AR3 then issues the following clearance:

- **AR3**: *"AAL24, Three Miles from LEGRE, Maintain Three Thousand until established on the localizer, Cleared ILS 18R. Follow Designated Traffic"*
- **AAL24:** *"Cleared ILS 18R, following UAL91, AAL24"*
- **AR3:** *"AAL24, Maintain 170 knots to the marker"*
- **AAL24:** *"170 to the marker, AAL24"*

UAL91 is now over the FAF and is told to contact tower.

The flight crew of AAL24 observes that the spacing behind UAL91 is 3.0 miles and the differential ground speed is +10 knots. Based on the information provided by their avionics, the flight crew elects to continue at 170 knots to the marker and then begin reducing to their final approach speed.

Since ENY2255 is not CAS equipped, AR3 handles the aircraft normally and issues a turn followed by the ILS18R approach clearance.

- **AR3:** *"ENY2255, turn right heading 150° and join localizer"*
- **ENY2255:** *"Heading 150° to join the localizer, ENY2255"*
- **AR3**: "*ENY2255, Three Miles from LEGRE, Maintain Three Thousand until established on the localizer, Cleared ILS 18R. Maintain 170 knots to the marker."*

- **ENY2255:** *"Three thousand until established, cleared ILS 18R. One seventy to the marker. ENY2255."*

AR3 recognized that AAL73 was CAS equipped and due to smaller spacing needed inside the FAF, initially told the aircraft to maintain 210K to compress the spacing behind ENY2255.

- **AR3**: "*AAL73, Maintain 210 knots, Designate ENY2255*."

The flight crew of AAL73 initially searches for ENY2255 but is unable to identify the aircraft. The flight crew then uses the search function on the MCDU to locate ENY2255 but is again unsuccessful. Since the flight crew of AAL73 is unable to either identify or designate ENY2255, they contact ATC and advise they are not able to conduct a CAS operation.

- **AAL73**: "*Unable to Follow Designated Traffic, AAL73.*"

Since AAL73 cannot perform CAS, AR3 needs to expand the reduced spacing by reducing speed and slightly extending the base leg.

- **AR3**: "*AAL73, Reduce speed to 170, maintain present heading*"
- **AAL73**: "*Reducing to 170, present heading, AAL73*"

AR3's control actions increased the spacing between AAL73 and ENY2255 to 4 NM, so AR3 turns AAL73 and issues the approach clearance.

- **AR3**: "*AAL73, Three Miles from LEGRE, turn right heading 150°, Maintain Three Thousand until established on the localizer, Cleared ILS 18R."*
- **AAL73**: "*Heading 130, three thousand until established, Cleared ILS 18R, AAL73*"

At this point, AAL24 is over the FAF, so they are told to contact tower. The CAS operation ends when UAL91 lands on runway 18R.

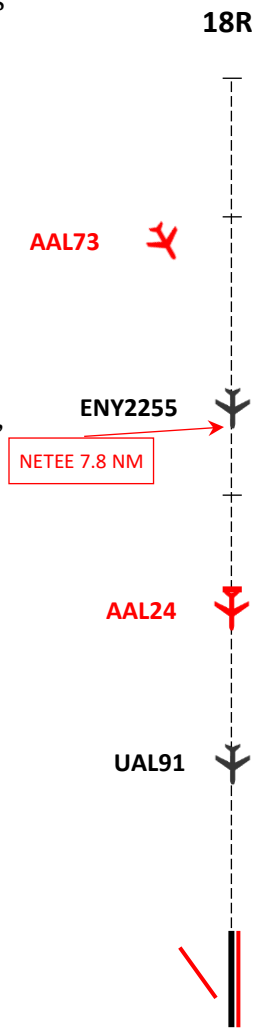


*Figure E-3 - AR3 Runway 18R Remaining Actions*

**AR1 Runway 17L Initial Setup**

AR1 recognized that AAL428 was CAS equipped and due to smaller spacing needed inside the FAF, initially told the aircraft to maintain 210K to compress the spacing behind ENY2143

AR1 previously issued the following:

- **AR1**: *"AAL428, Maintain 210 knots, Designate Echo-November-Yankee 2143.."*
- **AAL428:** *"Maintain 210 knots, searching, AAL428"*
- **AR1:** *"AAL428, Turn left heading 200 and join the localizer."*
- **AAL428:** *"Heading 200 to join the localizer, AAL428"*

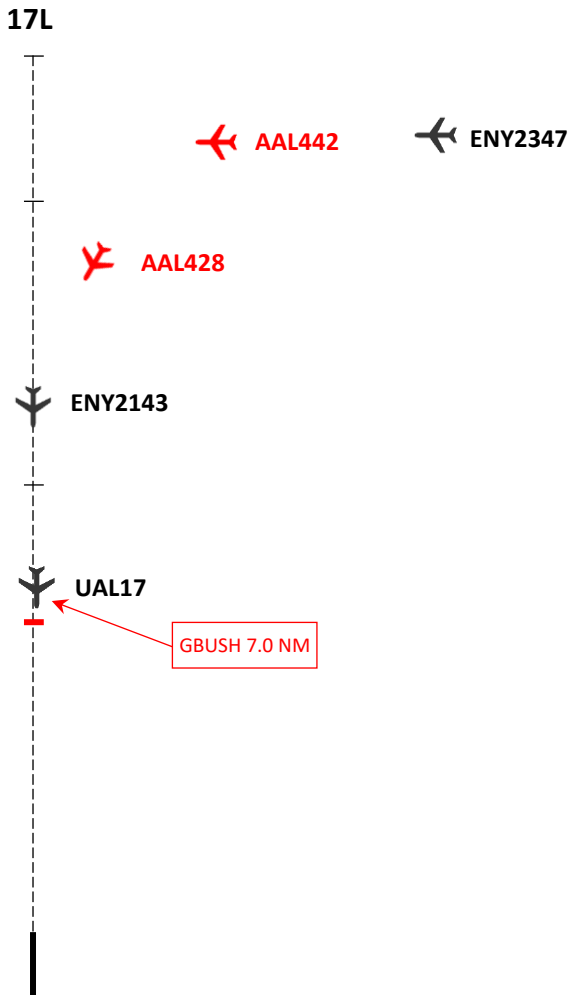


*Figure E-4 - AR1 Runway 17L Initial Setup*

**AR1 Runway 17L Remaining Actions**

AAL428 searches for, identifies and designates ENY2143. Once designated, the AGD displays additional information, allowing the flight crew to observe the range, ground speed, differential ground speed and fight ID of ENY2143.

- **AAL428**: *"AAL428 has Designated Echo-November-Yankee 2143"*
- **AR1**: *"AAL428, Six miles from INWOD, Maintain four thousand until established on the localizer, cleared ILS 17L. Follow designated traffic."*
- **AAL428**: *"AAL428, Maintain four thousand until established on the localizer, cleared ILS 17L. Following Echo-November-Yankee 2143, AAL428"*

AAL428 receives a "TRAFFIC LOST" alert on their avionics

- **AAL428**: "*Traffic Lost, Unable to follow designated traffic, AAL428*,"

AR1 observes the current spacing between AAL428 and ENY2143 @ 3.2 NM and a 20 knot overtake. Based on this information AR3 determines the approach may continue with controller intervention.

- **AR1**: "*AAL428, Cancel CAS, Reduce to final approach speed*"
- **AAL428**: "*Reducing to final approach speed, AAL428*"

If the controller had determined there was insufficient spacing to maintain separation, they would issue go-around instructions

- **AR1**: "*AAL428, go-around, maintain present heading, climb and maintain four thousand."*

- **AAL428:** *"Go around, present heading climbing to four thousand, AAL428"*

AR1 recognized that AAL442 was CAS equipped and due to smaller spacing needed inside the FAF, initially told the aircraft to maintain 210K to compress the spacing behind AAL428

- **AR1**: "*AAL442, Maintain 210 knots, Designate AAL428. Report Designated."*
- **AAL442**: "*Maintaining 210 knots. Looking, AAL442*"

AAL442 searches for, identifies and designates AAL428. Once designated, the AGD displays additional information, allowing the flight crew to observe the range, ground speed, differential ground speed and fight ID of UAL 91.

- **AAL442**: "*AAL442 has Designated AAL428*."

The spacing between AAL442 has not compressed as much as the controller had intended, so they begin the turn to final slightly early to further compress the reduced spacing. Since AAL442 is approaching 5 NM from the final, the controller also reduces AAL442's airspeed to 190 knots.

**AR1:** *"AAL442, Turn left heading 200, join the localizer, reduce speed to 190"*

**AAL442:** *"Heading 200, join the localizer, reducing to 190. AAL442"*

**AR1**: "*AAL442, eight miles from INWOD, Maintain four thousand until established on the localizer, cleared ILS 17L"*

**AAL442**: "F*our thousand until established, cleared ILS 17L"*

**AR1**: "*AAL442, Follow designated traffic, Maintain 170 knots or greater to the marker"*

**AAL442**: "*AAL442 following AAL428, 170 knots or greater to the marker"*

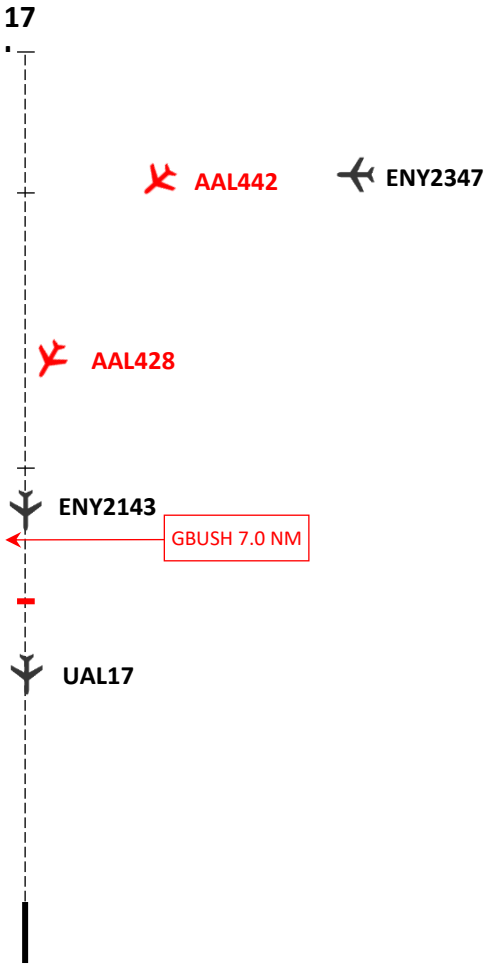


*Figure E-5 - AR1 Runway 17L Remaining Actions*

## Appendix F. CAS Capability Indication

Air traffic controllers need to know which aircraft in the AAL A321 fleet are capable of CDTI-Assisted Separation (CAS) operations. Capable in this context means that the aircraft has the appropriate avionics installed and a trained flight crew. In the future, ADS-B In Capability status for aircraft will be provided on the STARS display, but this enhancement to STARS is not expected to be available for CAS operations at D10 during the time frame of the AIRS operational evaluation.

A workaround known as the A321 Aircraft Type Identifier Workaround (A321 Workaround) will be used for the CAS Operational Evaluation to indicate which AAL aircraft are capable of CAS operations. Once the CAS Operational Evaluation begins, all aircraft filed as AAL A321 in the flight plan will be capable of CAS operations. Thus, to identify which aircraft are capable of the CAS operation, controllers will need to look at the fourth line of the ERAM display to determine whether the aircraft is depicted as AAL A321 and is therefore capable of CAS operations.

The AAL A321 fleet consists of both A321ceo and A321neo aircraft, and American Airlines will not have the entire A321 fleet equipped prior to the start of CAS operation, although all the flight crews flying the A321 will be trained to perform CAS operations. As part the A321 Workaround, American Airlines will be changing the aircraft type designator for some of the A321ceo aircraft some of the A321neo aircraft as described below:

- Equipped ceo → file as A321 (no change)
- Equipped neo → file as A321 (change for A321 Workaround)
- Unequipped ceo → file as A21N (change for A321 Workaround)
- Unequipped neo → file as A21N (no change)

Thus, all equipped A321ceo and A321neo aircraft will be filed as A321, and all unequipped A321ceo and A321neo aircraft will be filed as A21N. The A321 Workaround is necessary until all the AAL A321 fleet is equipped or the ERAM ADS-B In Capability Indicators have been deployed.

An A321 Workaround Safety Risk Management Panel was held on July 15, 2021. Three Low level hazards were identified. The A321 Workaround Safety Risk Management Document is being finalized and signatures are expected early in CY 2022.

More detail on the A321 Workaround can be found in the following documents:

- ADS-B In Retrofit Spacing (AIRS) ADS-B In Capability Indicator Workaround Using the A321 Type Designator, Rev 2.0, September 9, 2021 (Word document)
- A321 Workaround Description, Version 2 (PowerPoint slides)
- (Draft) A321 ADS-B In Retrofit Spacing Evaluation (AIRS Eval) A321 Workaround Safety Risk Management Document (SRMD)

## Appendix G. CDTI Assisted Separation (CAS) Flight Deck System Description

CDTI Assisted Separation (CAS) operations are conducted using the same system that is certified for CDTI-Assisted Visual Separation (CAVS) operations. The system that is being installed in the American Airlines A321 fleet is provided by ACSS and known as the SafeRoute+ system. The SafeRoute+ capability supporting CAS is certified per the CAVS application in FAA Technical Standard Order (TSO) C-195b. The SafeRoute+ system provides Airborne Surveillance and Separation Assurance Processing (ASSAP) and Cockpit Display of Traffic Information (CDTI) to support ADS-B In applications such as Enhanced Airborne Situational Awareness (AIRB) and CDTI Assisted Visual Separation (CAVS) and are compliant with FAA Technical Standard Order (TSO) C-195B requirements. This includes the requirements associated with traffic positional data quality parameters used for CAVS and validation of these parameters using TCAS validation as an independent source (i.e., range to the traffic calculated with ADS-B information checked against the range from TCAS active surveillance every 10 seconds when the aircraft are within 5 NM of each other).

The Cockpit Display of Traffic Information (CDTI) provides the control and display of CAS information in the flight deck. The CDTI, as depicted in Figure G-1, includes the combination of the following flight deck displays:

1. TCAS Display on the Navigation Display (ND)
2. ADS-B Guidance Display (AGD)
3. Multi-Purpose Control Display Unit (MCDU)


*Figure G-1 - SafeRoute+ CDTI*

The TCAS Traffic Display (overlaid on the Primary Flight Navigation Display) provides traffic situational awareness by displaying ADS-B traffic using typical TCAS symbology as well as TCAS traffic (as provided in Today's flight decks). The TCAS display does not provide any CAS specific information other than indicating the designated traffic.

The ADS-B Guidance Display (AGD) provides enhanced traffic situational awareness in the flight crew's forward-field-of-view with a graphical representation of surrounding traffic much like the existing TCAS display but adds traffic directionality and additional traffic information provided by ADS-B for Selected and Designated Traffic. Individual traffic can be "Selected" by the flight crew allowing display of additional information for the traffic such as flight identification (ID), distance from own aircraft, and ground speed. Also, individual traffic can be "Designated" by the flight crew clearly identifying the aircraft to follow and provide additional information used by the flight crew to manage spacing during a CAS operation. This additional information includes distance from own aircraft, Designated traffic ground speed, and differential ground speed (i.e., difference in ground speeds between own aircraft and Designated traffic).

The AGD traffic display depicts a top-down view of surrounding traffic and is limited to eight traffic symbols plus a designated traffic symbol, for a maximum of nine.

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

- Flight Identification (Flight ID)
- Traffic Vertical Direction Indicator (Climb or Descent)
- Traffic Relative Altitude (In hundreds of feet)

The AGD traffic display range can be adjusted to a range of 2.5, 5, 10, 20 and 40 NM by rotating the AGD Control Knob. The selected range is indicated above the AGD Control Knob.

When the "ACK" (Acknowledge) prompt is displayed above the AGD Control Knob, the Control Knob Button can be pressed to dismiss the displayed message.

The AGD CAS Aircraft display orientation of the traffic display is either Heading (HDG) or Track (TRK) and orientation indicated at the top of the range ring.

Traffic is represented on the AGD using symbol shapes and colors as shown in Figure G-2. 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 Traffic

Gray – Circular background to a traffic symbol to indicate selected traffic

| AGD Traffic Symbols | | | | |
|---|---|---|---|---|
| **Symbol Type** | **Normal Other** | **Normal Proximate** | **Caution** | **Warning** |
| Airborne Non-Directional Basic Traffic (ADS-B, ADS-R, or TCAS-Only Tracks) |  |  |  |  |
| Airborne Non-Directional Selected Traffic (ADS-B or ADS-R Tracks) |  |  |  |  |
| Airborne Non-Directional Designated Traffic (ADS-B Tracks) |  |  |  |  |
| Airborne Directional Basic Traffic (ADS-B or ADS-R Tracks) |  |  |  |  |
| Airborne Directional Selected Traffic (ADS-B or ADS-R Tracks) |  |  |  |  |
| Airborne Directional Designated Traffic (ADS-B Tracks) |  |  |  |  |
| Ground Non-Directional Selected Traffic (ADS-B, ADS-R, or TIS-B Tracks) |  |  | N/A | N/A |
| Ground Non-Directional Designated Traffic (ADS-B Tracks) |  |  | N/A | N/A |
| Ground Directional Selected Traffic (ADS-B, ADS-R, or TIS-B Tracks) |  |  | N/A | N/A |
| Ground Directional Designated Traffic (ADS-B Tracks) |  |  | N/A | N/A |

*Figure G-2 - AGD Traffic Symbols*

The MCDU allows the flight crew to interact with the SafeRoute+ ADS-B In system such as selecting/designating traffic, entering application data, and display of additional traffic information (i.e., aircraft identification, ground speed, range, altitude, etc.). The MCDU allows the flight crew to select or designate the aircraft to follow from the ATC provided instruction.

Once the flight crew receives a CAS instruction from ATC, the flight crew can select the specified traffic to follow via the MCDU Traffic list using the Flight ID provided in the instruction.

The AGD Traffic display provides Flight ID, distance, and ground speed of the selected traffic as shown in Figure G-3.


*Figure G-3 - Example AGD - AIRB Selected Traffic*

The MCDU Traffic Information page provides additional traffic information for the flight crew when traffic is selected on the MCDU Traffic List page. The Traffic Information page includes the following traffic data fields reported from the Selected Traffic:

- Flight Identification (Flight ID)
- Traffic Bearing (in clock direction)
- Traffic Range (NM)
- Traffic Track Angle (MAGNETIC or TRUE referenced, based on installation aircraft configuration file)
- Traffic Relative Altitude (FT)
- Traffic Vertical Speed (FT/MIN)
- Traffic Emitter Category
- Traffic Ground Speed (KT)

The possible displayed Traffic Emitter Categories are as follows:

- “LIGHT”
- “MEDIUM”
- “HEAVY”

The flight crew designates traffic from the MCDU Traffic Information page by selecting the Designate ON/OFF prompt shown in Figure G-4.


*Figure G-4 - Traffic Select On/Off Prompt (Airbus)*

The AGD Traffic display provides Flight ID, distance, ground speed, and differential ground speed of the designated traffic as shown in Figure G-5.


*Figure G-5 - Example AGD - CAS Display Layout*

Differential Ground Speed provides the flight crew with an indication of Designated Traffic over-take. Differential Ground Speed is represented as the amount own-ship’s ground speed that is “FASTER” or “SLOWER” than the designated traffic’s ground speed. The example shown in Figure G-6 indicates that own-ship ground speed is 10 knots slower than the designated traffic’s ground speed.


*Figure G-6 - AGD - Differential Ground Speed*

The MCDU Traffic Information page for the Designated Traffic provides additional traffic information for the flight crew. Differential Ground Speed and the "Traffic Range" Alert fields appear when traffic is designated. The color of the data fields indicates if the traffic is designated or not designated. The data fields are green if the traffic is designated. An example of the MCDU Traffic Information page is shown in Figure G-7.


*Figure G-7 - Example MCDU Traffic Information Page - CAS Designated Traffic*

The Traffic Designate On/Off prompt can be pressed to designate traffic. The Traffic Designate On/Off prompt is only displayed on the Traffic Information page when the traffic has sufficient quality for performing a CAS operation.

When traffic is designated, a pilot selectable range alert threshold will be displayed in cyan with a default value of 2.5 NM, as shown in Figure G-8. The flight crew can modify the default value by entering a valid value (1.4 - 10 NM) to the field.


*Figure G-8 - Traffic Range Alert*

During a CAS approach, an advisory message "TRAFFIC RANGE" is displayed in reverse white on the AGD, as shown in Figure G-9, with no associated aural indication when the designated traffic horizontal range becomes closer than the range alert threshold. The range alert threshold is adjustable on the MCDU Traffic Information page for the designated traffic. The advisory message is inhibited when either own-ship or the designated traffic is on-ground. Also, this message is acknowledged by pressing the AGD Control Knob button and is removed when the designated traffic horizontal range becomes greater than the range alert threshold.


*Figure G-9 - Traffic Range Alert*

A caution message “TRAFFIC MIN RANGE” is displayed in reverse amber on the AGD, as shown in Figure G-10, along with a “TRAFFIC RANGE” aural when the CAS designated traffic horizontal range becomes closer than 1.4 NM. The caution message is inhibited when either own-ship or the designated traffic is on-ground. The “TRAFFIC MIN RANGE” message cannot be cleared by pressing the AGD Control Knob button. This message is removed when the designated traffic horizontal range becomes greater than 1.4 NM.


*Figure G-10 - Traffic Minimum Range Alert*

The advisory message “TRAFFIC LOST” appears in reverse white on the AGD, as shown in Figure G-11, when the CAS designated traffic no longer meets the quality for CAS or can no longer be tracked. This message is acknowledged by pressing the AGD Control Knob button. The designated traffic information is removed from the display.


*Figure G-11 - CAS Traffic Lost Message*

## Appendix H. References

**Coates, P and et al. 2018.** *Research to Reduce Minimum Required Separation (MRS) on Final Approach: Concept, Feasibility, and Benefits.* McLean, VA : The MITRE Corporation, 2018.

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