ADS-B In Retrofit Spacing (AIRS) Initial–Interval Management (I-IM) Operational Description

Version 2.0

1 June 2022

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

Record of Revisions

Revision	Date	Description of Change
1.0	12/8/17	Initial Draft Release
1.1	2/01/2018	Major edits subsequent to document review and F2F discussion.
1.2	2/14/2018	The initial draft version for the Operational Working Group
1.21	3/27/2018	Minor changes in initial phraseology concept
1.3	5/24/2018	Major edits subsequent to F2F and Operational Working Group discussions
1.4	10/2/2018	Major edits based on Operational Working Group feedback
1.5	3/20/2019	Major edits in preparation of ZAB review
1.6	1/1/2020	Minor edits in preparation of ZAB review
1.61	1/27/2020	Minor edits changing “terminate” to “cancel” and Planned Termination Point (PTP) to Planned Cancellation Point (PCP)
1.62	3/11/2020	Added Document To-Do List
1.7	6/17/2020	Added procedures for Distance Based ASG for MIT Operation Added Flight Crew actions Added I-IM System Description Added phraseology for Descend Via while on IM Clearance
1.8	9/10/2020	Major Edits subsequent to Operational Working Group review
1.9	2/2022	Major Edits to incorporate ZAB specific procedures and scenarios
1.9.1	3/2022	Edits to procedures and scenarios to reflect February 2022 meeting with stakeholders
1.9.2	3/30/2022	Edits based on team review of 1.9.1
1.9.3	4/01/2022	Edits from 31Mar ZAB telecon
1.9.4	4/28/2022	Edits from 27Mar ZAB meeting
1.9.5	5/16/2022	Updated Appendix C, captured self-reporting in Table 2-1
2.0	6/1/2022	Removed draft notations; updates for loss of communications and cross-sector coordination based on Safety Risk Management Panel discussions

CONTENTS

1 Introduction 1-1
1.1 Document Description 1-1
1.2 Background 1-1
1.3 Trial Domain / Environment 1-2
1.4 Aircraft Separation/Spacing Criteria 1-3
2 Operational Description, Roles, and Procedures 2-1
2.1 I-IM Overview 2-1
2.1.1 Clearance Types 2-2
2.2 Limitations and Constraints on IM Operations for the AIRS Trial 2-4
2.3 Roles and Responsibilities 2-5
2.4 Operational Phases 2-6
2.4.1 Pre-Initiation 2-6
2.4.2 Initiation 2-6
2.4.3 Execution 2-6
2.4.4 Cancellation 2-7
2.5 Off-nominal Conditions 2-7
3 Procedure Description 3-1
3.1 Procedure Overview 3-1
3.1.1 Pre-initiation 3-2
3.1.2 Initiation 3-4
3.1.3 Execution 3-6
3.1.4 Cancellation 3-8
3.2 Phraseology 3-8
3.2.1 IM Clearance Readiness 3-9
3.2.2 IM Clearance Issuance 3-9
3.2.3 IM Clearance Acceptance 3-9
3.2.4 IM Clearance Amendment 3-10
3.2.5 IM Status Reporting 3-11
3.2.6 IM Spacing Report 3-11
3.2.7 Descend-Via Clearance during IM Operation 3-11
3.2.8 IM Cancellation Initiated by ATC 3-12
3.2.9 IM Cancellation Initiated by IM Aircraft 3-13
4 Operational Scenarios 4-1
4.1 Scenario # 1: MIT for Overflights to KDFW 4-1
4.1.1 Pre-initiation 4-3
4.1.2 Initiation 4-4
4.1.3 Execution 4-5
4.1.4 Cancellation 4-6
4.2 Scenario # 2: MIT for Overflights to KSAN 4-7
4.2.1 Pre-initiation 4-8
4.2.2 Initiation 4-9
4.2.3 Execution 4-9
4.2.4 Cancellation 4-10
4.3 Scenario # 3: PINNG Arrivals to KPHX 4-11
4.3.1 Pre-initiation Pair 1 4-13

4.3.2 Initiation Pair 1 4-14
4.3.3 Execution Pair 1 4-14
4.3.4 Cancellation Pair 1 4-17
4.3.5 Pre-initiation Pair 2 4-17
4.3.6 Initiation Pair 2 4-18
4.3.7 Execution Pair 2 4-19
4.3.8 Cancellation Pair 2 4-20
4.4 Scenario # 4: EAGUL Arrivals to KPHX 4-21
4.4.1 Pre-initiation 4-23
4.4.2 Initiation 4-23
4.4.3 Execution 4-24
4.4.4 Cancellation 4-25
5 Reference Documents 5-1
Appendix A. Glossary A-1
Appendix B. Acronyms B-2
Appendix C. Example of an ASG Lookup Table C-1

List of Figures

Figure 1-1. ZAB Airspace 1-3

Figure 2-1. Flight Deck Avionics -clockwise from left: AGD, traffic display, and MCDU..... 2-2

Figure 2-2. Maintain Clearance 2-3

Figure 2-3. Cross Clearance 2-3

Figure 3-1. SWIM Tool 3-1

Figure 3-2. A321 Workaround to Identify IM Capability - IM Capable (left) and Not IM Capable (right) 3-2

Figure 3-3. ERAM Fourth Line Annotation of IM Aircraft with Time-based ASG 3-4

Figure 3-4. SafeRoute+ MCDU Spacing Page 3-5

Figure 3-5. SafeRoute+ AGD 3-6

Figure 4-1. Scenario #1 - MIT for Overflights to KDFW 4-2

Figure 4-2. IM Quick Reference Card 4-4

Figure 4-3. ERAM 4th Line Annotations of IM Aircraft (left) and Lead Aircraft (right) 4-5

Figure 4-4. Scenario #2 – MIT for Overflights to KSAN 4-7

Figure 4-5. Scenario #3 - PINNG Arrivals to KPHX: Pair 1 Initiation 4-11

Figure 4-6. ERAM 4th Line Annotation of IM Aircraft with Time-based ASG 4-14

Figure 4-7. Scenario #3 – PINNG Arrivals to KPHX: Pair 1 Amendment 4-16

Figure 4-8. Scenario #3 – PINNG Arrivals to KPHX: Pair 2 Initiation 4-18

Figure 4-9. Scenario #4 – EAGUL Arrivals to KPHX 4-21

List of Tables

Table 2-1. Controller and Flight Crew Responsibilities 2-5

Table 4-1. Scenario #1 Sector Responsibilities 4-2

Table 4-2. Scenario #1 Key IM Parameters 4-3

Table 4-3. Scenario #2 Sector Responsibilities 4-7

Table 4-4. Scenario #2 Key IM Parameters 4-8

Table 4-5. Scenario #3 Sector Responsibilities 4-11

Table 4-6. Scenario #3 Key IM Parameters 4-12

Table 4-7. Scenario #4 Sector Responsibilities 4-21

Table 4-8. Scenario #4 Key IM Parameters 4-22

1 INTRODUCTION

1.1 Document Description

This document defines the Operational Description for Initial-Interval Management (I-IM) for the Automatic Dependent Surveillance-Broadcast (ADS-B) In Retrofit Spacing (AIRS) Evaluation and provides the underlying flight crew and controller tasks, roles, and responsibilities in sufficient detail to define the operations from the perspectives of Albuquerque Air Route Traffic Control Center (ZAB).

I-IM is a subset of the capabilities of Interval Management (IM)[1]. The full IM operation is described in RTCA DO-328B "*Safety, Performance and Interoperability Requirements Document for Airborne Spacing—Flight Deck Interval Management (ASPA-FIM)*"[4]. This subset consists of two IM clearance types, Cross (Achieve-by then Maintain in RTCA DO-328B) and Maintain (Capture then Maintain in RTCA DO-328B), which allow a properly equipped aircraft, known as the IM Aircraft, to achieve and/or maintain a desired spacing goal behind another aircraft, known as the Lead Aircraft.

The main objective of I-IM is to achieve consistent, low-variance spacing between paired aircraft during the level cruise or arrival phase of the aircraft's flight. Enabled by ADS-B reports from the Lead Aircraft, the IM (Trail) Aircraft calculates the necessary speed changes and presents those speeds to the flight crew for execution. Consistent, low variance spacing is expected to allow a reduction in inter-aircraft spacing objectives or restrictions, thereby reducing the time interval between the aircraft at the arrival runway threshold, resulting in increased arrival throughput. Overall efficiency should be increased by avoiding costly, low-altitude maneuvering.

Other benefits may be realized through I-IM including:

- Increased predictability of arrival traffic
- Reduced number of controller-issued instructions

1.2 Background

The Federal Aviation Administration (FAA), American Airlines (AAL), and Aviation Communication & Surveillance Systems, LLC (ACSS) are participating in the AIRS Evaluation. The AIRS project is a multi-year effort where three ADS-B In operations will be evaluated during revenue service on the American Airlines A321 fleet. The ADS-B In operations are Cockpit Display of Traffic Information (CDTI)-Assisted Visual Separation (CAVS), CDTI-Assisted Separation (CAS), and I-IM. American Airlines is in the process of equipping their entire A321 fleet with the avionics needed to support the ADS-B In operations. The flight deck equipment was developed by ACSS and is known as SafeRoute+™.

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

[1] I-IM is used to in this document to refer the programmatic application of a subset of IM capabilities for the AIRS Evaluation. However, participating controllers are assessing individual IM operations and participating aircraft are performing a unique IM operation, and those operations are referred to as "IM".

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. 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 leveraged the new architecture to make a business case for equipage, which led to the execution of a follow-on agreement between the FAA and ACSS and a commitment of AAL funding to support the equipage of the entire A321 fleet to perform CAVS and IM.

The FAA has planned automation upgrades for both the Standard Terminal Automation Replacement System (STARS) and En Route Automation Modernization (ERAM) system that include providing the controller with what is known as the ADS-B In Capability Indicator, which will provide controllers with the ability to know which aircraft and flight crews can perform ADS-B In operations. However, the planned upgrades will happen after the AIRS Evaluations are completed. A workaround has been identified that is called the A321 Aircraft Type Designator Workaround, or A321 Workaround. A321 aircraft capable of performing I-IM will be filed with the A321 aircraft type designator, while A321 aircraft not capable of performing I-IM will be filed with the A21N aircraft type designator. The workaround, associated assumptions, and other details are fully documented by the FAA, AAL, and ACSS [2].

The primary objective of this project is to promote the early adoption of ADS-B In applications by fielding a cost-effective retrofit solution that applies to a large addressable market.

1.3 Trial Domain / Environment

The I-IM operations, as described in this Operational Description, will be performed in ZAB airspace (see Figure 1-1) with AAL A321 aircraft on the “PINNG” and “EAGUL” Area Navigation (RNAV) Standard Terminal Arrival Route (STAR) into Phoenix Sky Harbor International Airport (KPHX), and overflight traffic subject to Miles-In-Trail (MIT) spacing. IM is an additional technique available to ZAB controllers to achieve the desired spacing.

I-IM operations will be conducted during either Visual Meteorological Conditions (VMC) or Instrument Meteorological Conditions (IMC) under Instrument Flight Rules (IFR) in airspace with Air Traffic Control (ATC) surveillance. For the trial, air traffic controllers will use existing ATC automation with the A321 Workaround.

The IM operation will consist of a Lead Aircraft and an IM Aircraft equipped with the SafeRoute+ equipment and appropriately trained flight crew. Multiple IM Aircraft may perform an IM operation given the appropriate conditions, either as separate pairs of aircraft or as series of aircraft (i.e., an IM Aircraft in one pair is simultaneously the Lead Aircraft in a second pair).

The routing for an aircraft pair will consist of either a common route or two separate routes merging at a common point, known as the Crossing Point (CP), followed by a common route. The routes prior to the CP, whether a published airway or direct to a fix, must be on a straight path directly toward the CP. Both routing types may include a Planned Cancellation Point (PCP) where the operation will end.

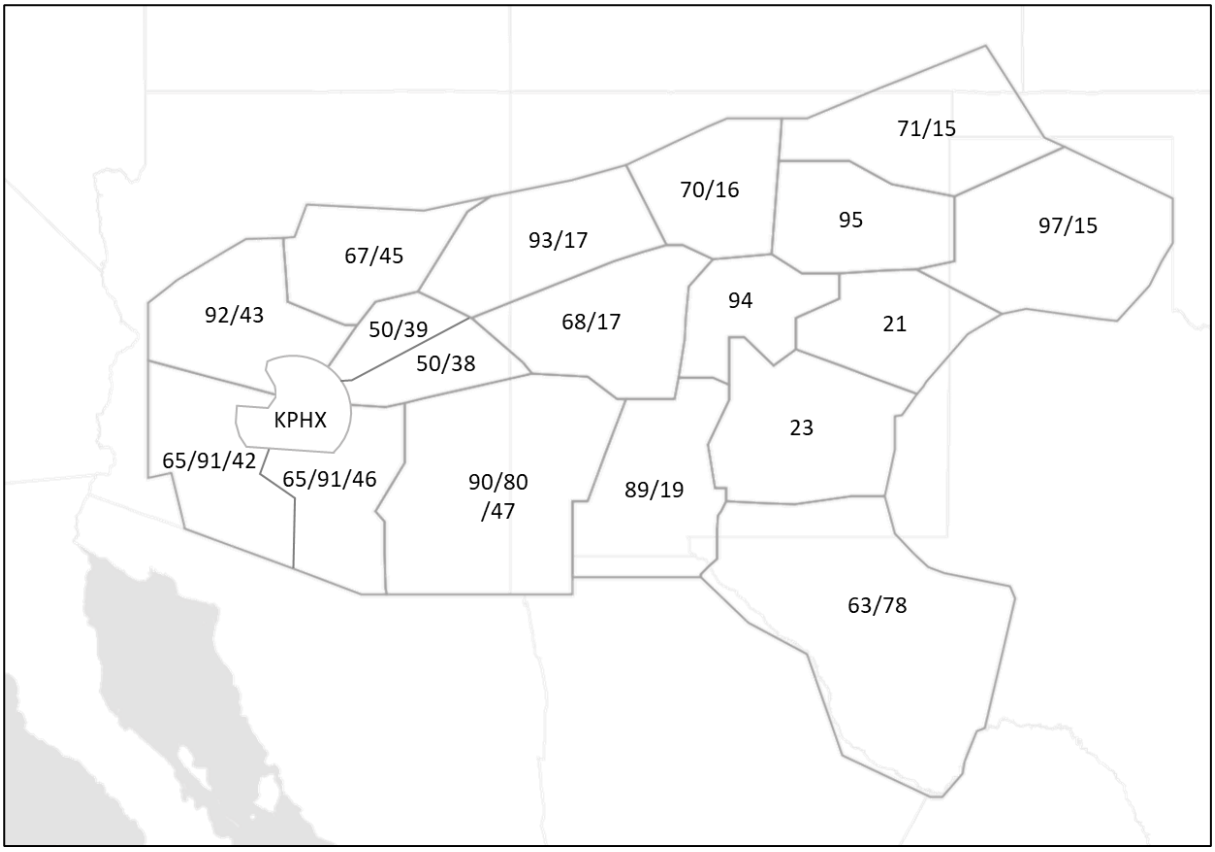

Figure 1-1. ZAB Airspace

The operational environment will include aircraft from several operators that are not equipped with the SafeRoute+ equipment. These aircraft will operate in the same airspace and arrive at the same airports while equipped AAL aircraft are conducting IM. Only AAL's aircraft equipped with the SafeRoute+ equipment will perform the role of the IM Aircraft in an aircraft pair. All aircraft equipped with ADS-B Out, regardless of the operator, may perform the role of Lead Aircraft in an aircraft pair.

1.4 Aircraft Separation/Spacing Criteria

There are no changes in separation or spacing criteria when using IM during the trial. ATC will determine the time- or distance-based Assigned Spacing Goal (ASG) for each IM operation. The ASG will not violate ATC spacing or separation requirements in FAA Order 7110.65 [3] and will conform to Letters of Agreement (LOAs) and other airport or runway constraints.

2 OPERATIONAL DESCRIPTION, ROLES, AND PROCEDURES

2.1 I-IM Overview

I-IM introduces new operations and procedures for flight crews and ATC to attain a desired spacing between two aircraft to a pre-determined fix in a manner consistent with today's IFR procedures and criteria. To conduct IM, a defined path must exist for participating aircraft which may include a suitable CP, PCP, and a structured terminal arrival procedure. The arrival procedure can be a routing via airways or a STAR. As defined in DO-328B [4], IM operations start with a Pre-Initiation Phase, continued by an Initiation Phase, followed by an Execution Phase, and ending with a Cancellation (Termination in RTCA DO-328B) Phase. Phases are defined by the procedural steps performed in each phase.

In the Pre-Initiation Phase, ATC identifies the potential IM Aircraft and Lead Aircraft, ASG, IM Clearance type, CP (when applicable), and PCP (optional). ATC determines the feasibility of the IM operations based on factors such as current spacing, remaining distance, conflicting traffic, and weather.

In the Initiation Phase, ATC provides an IM clearance to the IM Aircraft. The IM Aircraft flight crew enters the IM clearance information from the ATC-provided instruction into the MCDU in preparation for the Execution Phase. After the flight crew enters the clearance information into the avionics, the system performs an internal check to ensure all performance criteria are met and, in the case of a time-based Cross clearance, that the clearance is feasible. If, based on the I-IM Application feedback and other assessments by the flight crew, the clearance and initial parameters (i.e., the first commanded speed) is deemed acceptable, the flight crew will initiate the IM operation and the avionics will display the IM Speed on the AGD (the commanded speed depicted in Figure 2-1).

The Execution Phase begins when the IM Aircraft flight crew begins flying the initial IM Speed. The SafeRoute+ equipment will provide the flight crew with IM Speeds to realize and maintain the ASG. These IM Speeds are expected to be complied with by the flight crew in the same manner as a controller's speed instruction. The IM Aircraft flies IM Speeds until ATC cancels the operation, or the IM Aircraft reaches the PCP; at which time the IM procedure ends, and the avionics automatically cancels IM and discontinues displaying IM Speeds. The flight crew will then resume normal, published, or ATC assigned speeds.

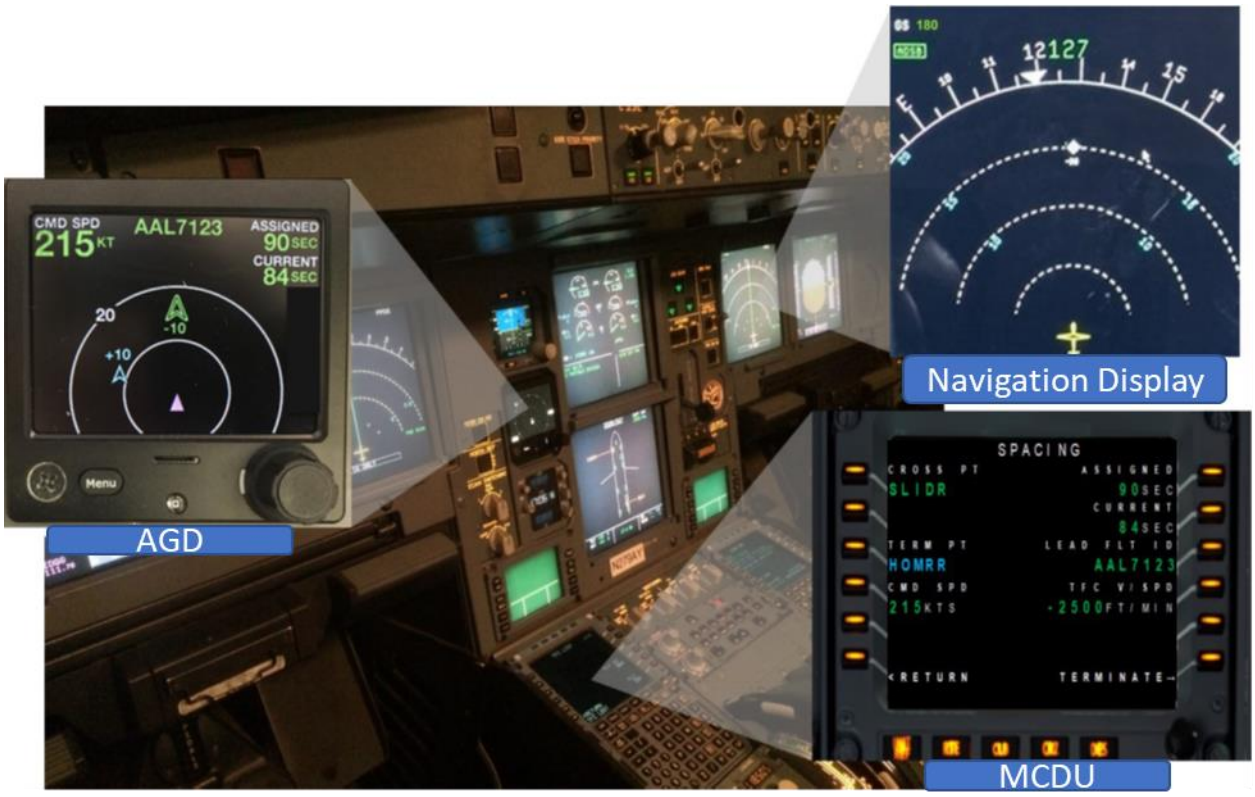

Figure 2-1. Flight Deck Avionics -clockwise from left: AGD, traffic display, and MCDU.

2.1.1 Clearance Types

The Maintain clearance type (see Figure 2-2) will be used when the IM Aircraft and Lead Aircraft are on a common route. The SafeRoute+ equipment will provide speeds such that the IM Aircraft will achieve the ASG as soon as possible. The flight crew flies IM Speeds until the operation is canceled or the IM Aircraft reaches the PCP.

The Cross clearance type (see Figure 2-3) will be used when the IM Aircraft and Lead Aircraft are initially on different routes that will merge at a common point, known as the Crossing Point (CP) and continue on a common route. The routes prior to the CP are required to be on a straight path directly towards the CP. The SafeRoute+ equipment will provide speeds such that the ASG will be attained at or before the CP. Once the CP is reached, the flight crew continues to fly IM Speeds until ATC cancels the operation or the IM Aircraft reaches the PCP. The PCP may be co-located with the CP.

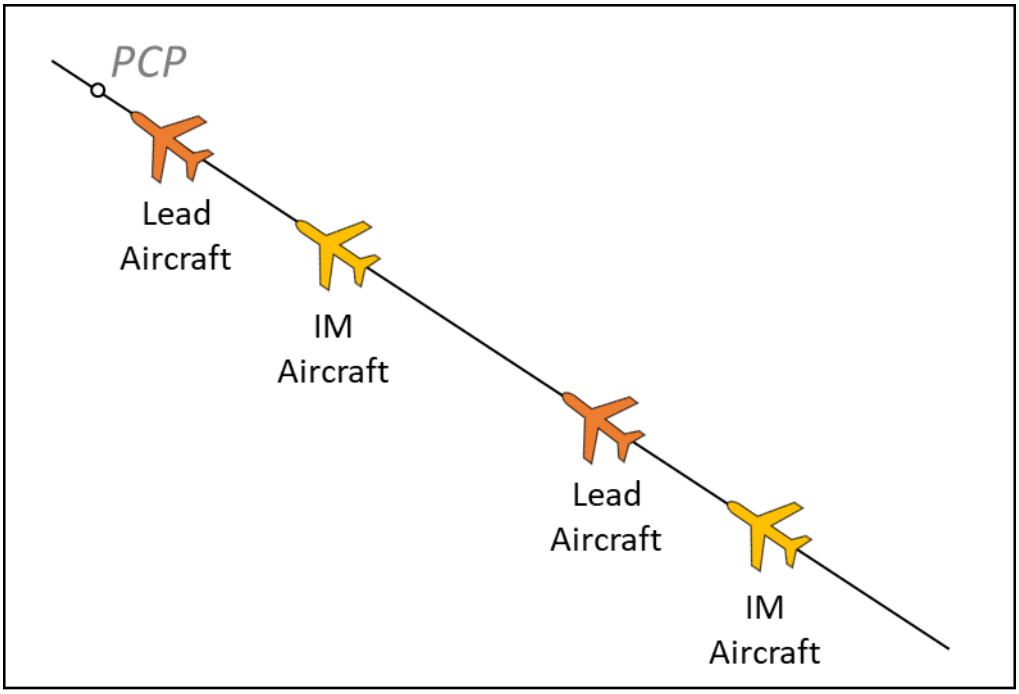

Figure 2-2. Maintain Clearance

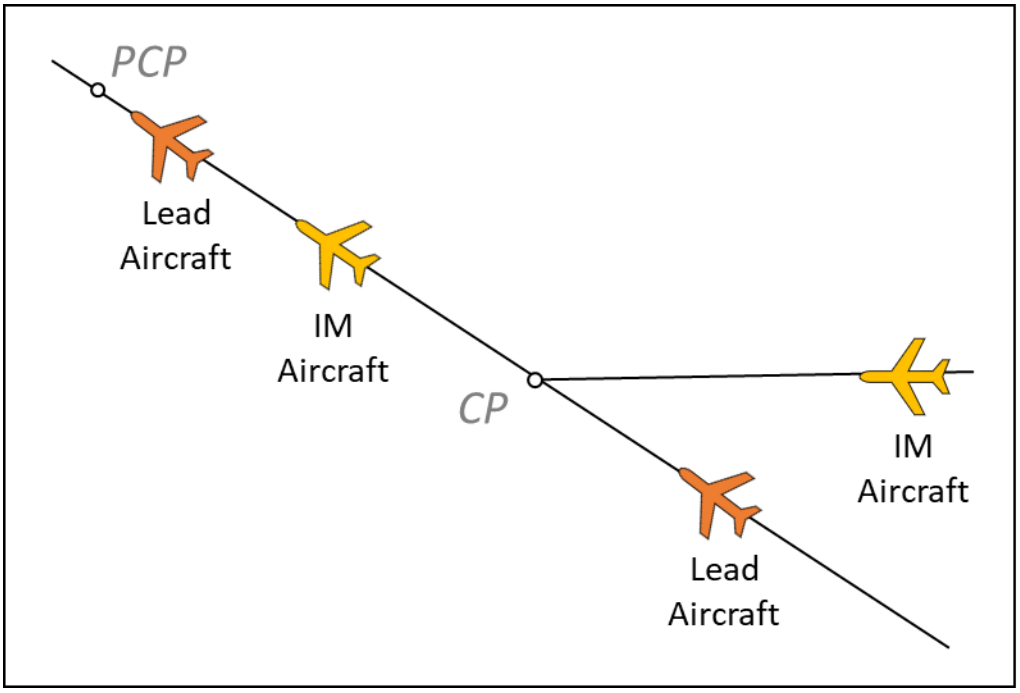

Figure 2-3. Cross Clearance

2.2 Limitations and Constraints on IM Operations for the AIRS Trial

All IM operations must be completed or canceled in ZAB airspace and may not continue into adjacent centers or the KPHX Terminal Radar Approach Control (TRACON) known as P50.

The SafeRoute+ equipment has important limitations that directly impact the controller and flight crew application of IM.

Path Conformance and Infeasibility Checking

- Aircraft must be on the same route or direct to a common merge – which will be the CP for a Cross clearance. In this case, direct to a common point means there can be no course changes between aircraft current position and the CP, though there may be intervening waypoints. The CP must be within a 40° cone of both aircraft tracks, meaning if either aircraft has been vectored or has course changes in the route, the IM operation should not be initiated until both aircraft are headed toward the CP. Prior to the CP, the equipment will cancel the operation and notify the flight crew if either aircraft in the pair fails this conformance check.

- During the maintain stage (i.e., same route), the cross-track difference between the IM Aircraft current position and Lead Aircraft historical position must be within 4 NM.

- To initiate a Maintain clearance, either the Lead or the IM Aircraft must be within a 6 NM swimlane around the other aircraft's instantaneous track as projected ahead of the IM Aircraft (or behind the Lead Aircraft), or the instantaneous tracks must have an intercept angle less than 90° and intersect between the two aircraft positions.

- The SafeRoute+ equipment does check the feasibility of achieving the Assigned Spacing Goal (ASG) by the CP prior to initiation for time-based Cross clearances; however, there is not a feasibility check of operations with distance-based ASGs or with any type of Maintain clearance. Therefore, controllers must be cognizant that they cannot rely on the avionics to flag operations that are likely infeasible from the start. Controllers will rely on their experience and judgment, and facilities may develop rules of thumb to ensure satisfactory initiation conditions.

IM Clearance Information

- IM special points (i.e., the PCP and CP) must be defined as a named fix. SafeRoute+ equipment will not accept an IM special point defined a distance before or after a named fix.

- A distance-based ASG must be in whole nautical miles (i.e., an integer value).

Other

- The SafeRoute+ equipment does not include a suspend function; however, the flight crew can cancel the operation and all Clearance Information will be retained and may be modified or re-activated.

2.3 Roles and Responsibilities

The following responsibilities are defined for participating controllers and flight crews based on those specified in DO-328B [4] and the limited scope of I-IM defined for the AIRS Evaluation.

Table 2-1. Controller and Flight Crew Responsibilities

Controller Responsibilities	Flight Crew Responsibilities
• Determining if an IM operation is desirable • Determining the IM Aircraft, the Lead Aircraft, the Assigned Spacing Goal, and any applicable IM Special Points • Verifying that all initiation criteria are met to ensure a reasonable expectation of a successful operation • Communicating the IM clearance to the IM Aircraft • Ensuring separation between the IM Aircraft and all other aircraft, including the Lead Aircraft • Monitoring for and detecting path and longitudinal deviations and providing instructions, when necessary • Amending the IM operation, as needed • Cancelling the IM operation if the goal is no longer applicable or is not being met • Resuming non-IM operations when the IM operation is canceled	• Determining whether to accept or reject the IM clearance • Making the IM clearance information available to the I-IM Application • Confirming IM clearance information to the controller via readback and upon request • Coordinating cross-cockpit verification of the IM clearance entry • Ensuring that IM Speeds do not conflict with the safe operation of the aircraft • Informing the controller if they are unable to accept the IM clearance • Implementing the IM Speed • Monitoring the SafeRoute+ equipment for any notifications and speed compliance alerts • Amending the IM operation, as instructed by the controller • Self-reporting the active IM operation on check-in with ATC • Cancelling the IM operation, as instructed by the controller • Informing the controller if they are unable to continue the IM operation

The Traffic Management Coordinator (TMC), Supervising Traffic Management Coordinator (STMC), and area supervisor may also have roles in determining IM pairs and time-based ASGs and coordinating that information with the appropriate controller. The TMC, STMC, and area supervisor may also support controllers when rescheduling, resequencing, or taking other actions causes changes to the Time-Based Flow Management (TBFM) schedule or sequence and

subsequently to the IM clearance elements. In these cases, controllers may wish to cancel all active IM operations; however, if a controller is interested in continuing an operation rather than canceling it, the TMC, STMC, or area supervisor can support the controller by helping to verify the pair and ASG.

2.4 Operational Phases

2.4.1 Pre-Initiation

The initial step to begin an IM operation is for ATC to identify an appropriately equipped AAL A321 aircraft. Once the IM Aircraft is identified, ATC will evaluate other aircraft to determine if a candidate Lead Aircraft exists. When TBFM metering is turned on, TBFM data may be used to determine the Lead Aircraft in the sequence, as well as the ASG. When TBFM is not in use, this determination is made considering several factors, such as initial spacing and operational goals. For IM to be successful, aircraft need to be in an appropriate sequence with adequate spacing during the en route phase of flight so that they can transition to IM in a suitable configuration. ATC will monitor the position of the candidate IM Aircraft and will identify potential IM Aircraft pairs based on their projected arrival times or controller-determined sequence at a shared fix on their flight plans.

2.4.2 Initiation

The Initiation phase begins when ATC issues an IM clearance to the flight crew. The clearance will include the type of clearance (Cross or Maintain), Lead Aircraft ID, ASG, CP (when issuing a Cross clearance), and, optionally, a PCP. The flight crew enters the clearance elements into the I-IM Application, performs a cross-cockpit verification of the entry, and executes the clearance, which triggers the SafeRoute+ equipment's Commanded Speed display (assuming initiation criteria are met).

In the case of a Cross clearance with a time-based ASG, the avionics performs a feasibility check to determine if the ASG can be attained by the CP. The avionics will then notify the flight crew of the clearance feasibility. In the case of an unsuccessful feasibility check or flight crew determination that the operation is not acceptable for other reasons, the flight crew notifies ATC and awaits further instructions.

2.4.3 Execution

The Execution phase begins when the IM Aircraft flight crew begins following the IM Speeds. The IM Aircraft flight crew is notified of a new IM Speed on the AGD.

With the presentation of each IM Speed, the IM Aircraft flight crew ensures that the IM Speed is acceptable considering the current aircraft configuration, environmental conditions, and airspace speed restrictions. If the flight crew determines they are unable to fly the IM Speed, they will contact ATC and report "unable" and await instruction. Otherwise, the flight crew follows the IM Speeds in order for the IM Aircraft to gradually achieve the ASG. Once the ASG is attained, the flight crew continues flying IM Speeds provided by the SafeRoute+ equipment to maintain the ASG.

ATC continues to monitor and is responsible for separation for all aircraft, including those involved in the IM operation, by using existing surveillance capabilities and procedures.

2.4.4 Cancellation

For the AIRS Evaluation, the use of a PCP is optional and is not expected to be used. Therefore, the ZAB controllers must cancel the IM clearance via voice instruction or by the issuance of another speed instruction to the IM Aircraft. If the IM Aircraft is given a speed instruction from ATC, the flight crew cancels the IM operation at which point IM Speeds are no longer provided. The flight crew will then fly speeds issued by ATC.

For IM Clearances that include a PCP, the SafeRoute+ equipment automatically cancels the I-IM Application when the IM Aircraft reaches the PCP. After cancellation, the SafeRoute+ equipment no longer displays IM Speeds. To avoid any potential confusion concerning flight crew action after cancellation, the controller must issue specific control instructions for the flight crew to follow.

2.5 Off-nominal Conditions

While off-nominal conditions can consist of emergencies and other abnormal events, more often they are relatively common occurrences, such as aircraft deviations due to convective weather, sector overload, or traffic.

Note: ATC altitude instructions alone do not create off-nominal conditions for IM operations, nor do ATC speed instructions to the Lead Aircraft.

ATC-initiated Heading Instructions

If ATC needs to provide a heading instruction to either aircraft at any time during the conduct of IM, it will do so. ATC-initiated heading instructions to either the IM Aircraft or Lead Aircraft affects IM. If ATC issues a heading instruction to the Lead Aircraft, they should also cancel the IM operation by advising the flight crew of the IM Aircraft.

- It is possible for the Lead Aircraft to take a heading off its route without the IM Aircraft's flight crew being notified to cancel IM. Once the I-IM Application detects that the IM Aircraft and the Lead Aircraft are no longer on the same route or direct to the same fix, it will notify the flight crew, cancel, and discontinue the display of IM Speeds. The IM Aircraft flight crew is not expected to detect this event on a display, such as a traffic display, prior to the termination message[2]. At this point, the flight crew notifies ATC they are unable to continue the IM operation. The IM Aircraft flight crew is expected to continue flying their current speed until ATC issues a new speed or they encounter a procedurally required speed.
- If the IM Aircraft is taken off route or receives a vector from ATC, the flight crew flies that heading and cancels the IM operation at which point IM Speeds are no longer provided. The IM Aircraft flight crew is expected to continue flying their current speed until ATC issues a new speed or they encounter a procedurally required speed.

[2] The SafeRoute+® equipment uses "termination" rather than "cancellation."

Unacceptable IM Speeds

If operational constraints (e.g., turbulence) result in the flight crew being unable to follow the IM Speed, they may limit the speed to an operationally acceptable speed. The flight crew conforms to the IM Speed once it becomes operationally acceptable. The flight crew will notify ATC "Unable Spacing" and include their speed and intentions. In cases where the IM Aircraft flight crew is unable to return to conforming to the IM Speeds, the flight crew cancels the IM operation at which point IM Speeds are no longer provided. The flight crew will notify ATC they have canceled the IM procedure and then fly speeds issued by ATC or as required by procedure.

Intervening Aircraft

If ATC inserts an aircraft between an IM Aircraft conducting IM and its Lead Aircraft, ATC may choose to cancel IM and provide the IM Aircraft with a speed or vector instruction. Alternatively, if the assigned spacing is not in conflict with the separation requirements between any aircraft, ATC may allow the IM operation to proceed and continue to ensure separation between aircraft.

Call Sign Mismatch

Call Sign Mismatch (CSMM) occurs when the ADS-B Out broadcasted flight ID does not exactly match the call sign in the filed flight plan. The impact of CSMM during IM operations would be the inability of the flight crew to identify the Lead Aircraft within their avionics or the potential of the flight crew designating the incorrect aircraft as the Lead Aircraft. Once ATC becomes aware of CSMM, either through an ERAM generated CSMM alert or the inability of the IM Aircraft flight crew to identify the Lead Aircraft, ATC must follow guidance contained in *FAA JO 7110.65 para. 5-2-26 a* [3]. *ADS-B Alerts* and reject the use of the CSMM aircraft as the Lead Aircraft in an IM operation.

TBFM Rescheduling and Resequencing Events

A TBFM reschedule of a previously frozen flight may result in changes to the sequence of aircraft or the differences in an IM pair's ASG derived from the new TBFM schedule. A manual swap, resequencing, or other coordinated event may also affect an active IM pair. In the event of a change to TBFM, the controller may choose to cancel, amend, or continue the IM operation(s). If controllers cancel IM due to TBFM changes to the schedule and/or sequence, they will continue to apply normal metering tools and procedures to achieve their objectives and may resume using IM when they choose. If the controller chooses to continue IM, each IM pair should be verified to confirm the correct sequence (i.e., confirming the Lead aircraft) and ASG.

Loss of Communication

If an IM Aircraft experiences a loss of radio communications during an active IM operation, the flight crew is expected to cancel the IM operation, fly the last implemented IM speed until a different speed is required for safety or by procedure, and comply with standard lost communication procedures.

3 PROCEDURE DESCRIPTION

3.1 Procedure Overview

The procedures described are based on the detailed IM procedures defined in Appendix A of DO-328B [4], with the following exceptions.

1. Partial clearances will not be used in the AIRS Evaluation.
2. IM will not be used in the terminal environment, nor will it be used on approach.
3. IM Turns are not supported by the SafeRoute+ equipment and will not be used.
4. ZAB controllers are expected to cancel IM if they need to direct either aircraft in a pair off route or issue a speed to the IM Aircraft; they will not use a "suspend" instruction.
5. Ground automation capabilities assumed in DO-328B [4] are not yet available during the AIRS Evaluation to support IM. However, the FAA has developed an application that can be hosted in the Traffic Management Unit (TMU) and on the area supervisor's desktop computer to retrieve aircraft TBFM schedules from the FAA's System Wide Information Management (SWIM) program and propose aircraft pairs and ASGs in a metering environment (see Figure 3-1). Additionally, a lookup table may be used to determine an appropriate time-based ASG based on a desired separation distance and assumed groundspeed. An example table is provided in Appendix C.
6. Based on these differences in ground automation and the need to capture ground-only procedures, additional controller tasks are defined for the AIRS Evaluation.
7. The I-IM project uses the term "cancellation" rather than "termination", though it should be noted "termination" and its variants are used in the SafeRoute+ equipment.

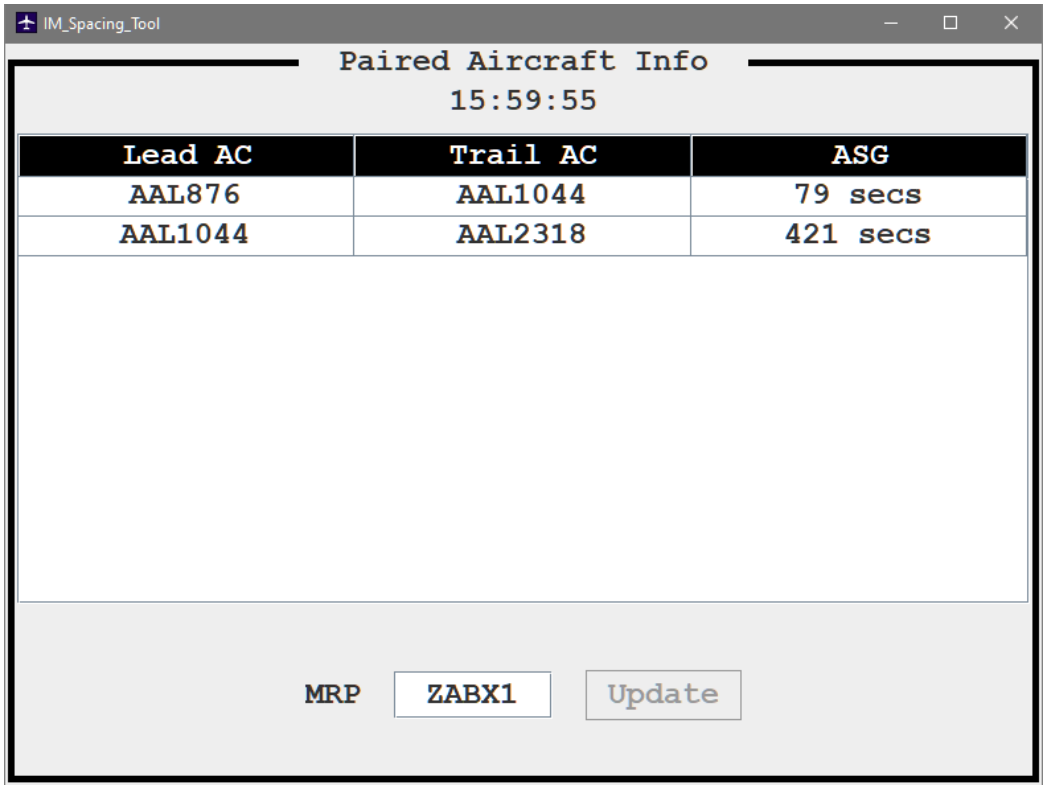

Figure 3-1. SWIM Tool

The application of these procedures is predicated on controllers in the facility being properly trained, the operational evaluation being live in a specific sector(s) or facility-wide, and AAL filing IM capability based on equipage and flight crew training via the A321 workaround [2].

The IM procedures are described in the four phases introduced in Section 2.4: pre-initiation, initiation, execution, and cancellation.

3.1.1 Pre-initiation

The controller will determine that use of an IM operation is desired. As the controller is managing and sequencing traffic, the controller will identify IM capable aircraft by the A321 type designation in the data block (see Figure 3-2).

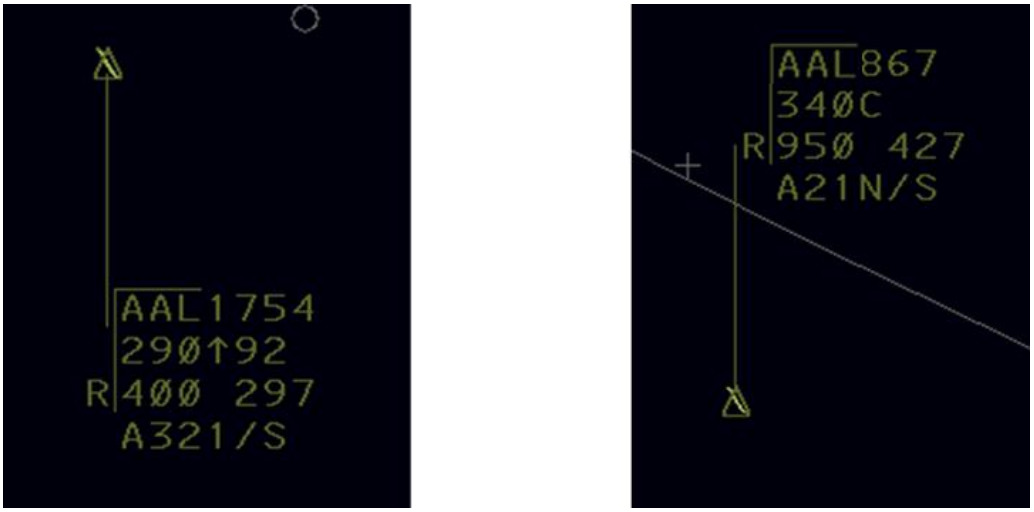

Figure 3-2. A321 Workaround to Identify IM Capability - IM Capable (left) and Not IM Capable (right)

The controller will identify suitable pairs (IM Aircraft and Lead Aircraft) as either in-sequence arrivals into KPHX or overflight traffic headed to the same destination airport on a common or converging route subject to a MIT restriction. Controllers may use destination and route information available through ERAM to assist in this determination. Controllers are not expected to initiate IM operations with a Lead Aircraft in another sector as this will require verbal coordination between controllers to ensure the Lead Aircraft is not vectored and fourth line annotations are appropriately applied. In other words, the controller initiating IM should have control of both the IM Aircraft and the Lead Aircraft.

The controller will then determine the remaining IM clearance elements: clearance type, CP if applicable, ASG, and optional PCP.

- **Clearance Type**: The clearance type will be determined by the geometry of the aircraft pair. If the aircraft are already on the same route, a Maintain clearance will be used. If the aircraft are headed direct to a common fix and subsequently will be on the same route, a Cross clearance will be used.
- **CP**: An appropriate CP for Cross clearance types may be a defined merge point on a STAR or jetway or may be a common route point used by ATC to merge and sequence

traffic. In either case, the point must be defined point in the navigation database and both aircraft in the pair must have a straight-line route to the merge.

- **ASG**:
    - Arrival pairs into KPHX may use either a time-based or distance-based ASG. The ZAB TMU will post details of Traffic Management Initiatives (TMIs) on the Enhanced Status Information System (ESIS) boards. The MIT restrictions for overflights leaving ZAB airspace will serve as the distance-based ASG for these IM operations.
    - When metering is turned on[3], time-based ASGs may be retrieved through the SWIM Tool. One instance of the application is needed for each meter reference point (MRP) of interest (see
    - Figure 3-1). The application filters the SWIM data for all frozen AAL A321 aircraft arriving to KPHX via the selected MRP. The proposed ASG is the difference in scheduled arrival times to the MRP between the AAL A321 (IM Aircraft) and the preceding aircraft (Lead Aircraft) in the TBFM-defined sequence. The controller will determine the time-based ASG by one of several options, including:
        - The area supervisor will open an instance of the SWIM Tool, and the controller and supervisor will coordinate directly to confirm the pair and ASG.
        - The area supervisor will open an instance of the SWIM Tool on a monitor in the area (e.g., the ESIS board), and the controller will find the appropriate pair and ASG directly from the board.
        - The TMC will open an instance of the SWIM Tool on a local computer and coordinate with the area supervisor to relay pairs and ASGs to appropriate controller.
    - If metering to KPHX is not in effect or a sector is applying MIT for arrivals, a distance-based ASGs may be determined from local Standard Operating Procedures (SOPs).
    - Alternatively, an ASG look-up table may be provided to controllers, supervisors, and TMCs to provide time-based ASGs for a desired in-trail distance at a given groundspeed (see **Error! Reference source not found.**).
- **PCP**:
    - For the AIRS Evaluation, the use of a PCP is optional and is not expected to be used; IM clearances will be canceled by the controller prior to leaving ZAB airspace or by the issuance of another speed instruction to the IM Aircraft. If a controller issues a PCP with the IM clearance, the controller must coordinate the PCP with downstream controllers if the PCP is outside the issuing sector.
    - For arrivals into KPHX, the nominal PCP will be documented in facility procedures for each arrival stream. Typically, this will be a waypoint on the STAR prior to the P50 boundary.
    - For overflights, the PCP will be available on the ESIS boards as part of the TMI.

[3] Time-based operations may also be supported when controllers are not actively metering (i.e., TBFM is scheduling aircraft and Scheduled Times of Arrival (STAs) are available to the TMU and through the SWIM Tool, but controllers are not required to meet the STAs and times are not shown on the controller displays).

ATC will ensure all applicable initiation conditions are satisfied prior to initiating the IM operation. A quick reference card will be provided to controllers to use as a checklist of initiation criteria, to include:

- The identified candidate IM Aircraft is an AAL A321.
- The identified candidate Lead Aircraft's ADS-B Out is operational.
- The aircraft pair satisfy the geometry and route constraints – both aircraft are already on the same route or are headed direct-to a common merge point and subsequently on the same route until the desired cancellation point.
- The IM special points are defined Navigation Aids (NAVAIDs) or waypoints.
- The aircraft are currently spaced such that achievement of the desired spacing is probable with speed only and additional vectoring of either aircraft is unlikely.
- The aircraft are within ADS-B range of each other (90 NM).

3.1.2 Initiation

The initiation phase begins when the controller communicates (via voice) the IM clearance to the flight crew of the IM Aircraft (see the phraseology defined in Section 3.2). The controller will record the IM Aircraft and Lead Aircraft in the fourth line of the respective data blocks on ERAM. "L" will be used to indicate a Lead Aircraft, while "T" will be used indicate a Trail Aircraft. If an aircraft is both a Lead Aircraft and a Trail Aircraft, "LT" may be used. If a time-based ASG is used, the controller will also record the time in seconds in the IM Aircraft's data block (see Figure 3-3); this is particularly valuable in an extended metering environment when the ASG may change at the next freeze horizon. Although a distance-based ASG, a CP when used, and PCP are typically pre-defined IM parameters (e.g., per a TMI or SOP), the controller may also choose to record these elements for later reference.

Figure 3-3. ERAM Fourth Line Annotation of IM Aircraft with Time-based ASG

Upon receiving the IM clearance, the IM Aircraft flight crew will:

- Reply to ATC, acknowledging the IM clearance.
- Assess the current IM capability of the aircraft and cancel an active IM operation, if applicable. This will include checking for any notifications or advisory messages in the

SafeRoute+ equipment that would prohibit execution of IM. If unable to accept the clearance, the flight crew will notify ATC of "Unable Spacing."

- Enter the ATC provided IM clearance information (Lead Aircraft identification, ASG, CP (as applicable), and PCP (if included) into the MCDU Spacing page (see Figure 3-4). The flight crew may select the Lead Aircraft from the MCDU Traffic page prior to entering the rest of the information on the Spacing page.
- As needed, the flight crew may request that ATC clarify or repeat the IM clearance.
- The entry of the IM clearance is verified by the other member of the flight crew.
- Review any messages (SPACING AVAILABLE or UNABLE SPACING) on the SafeRoute+ equipment resulting from a validity check of the entered information, including the route geometries and data quality of both aircraft. If invalid, the flight crew notifies the controller.
- Confirm acceptability of IM operation by evaluating any notifications or messages on the SafeRoute+ equipment, assessing the environmental conditions, reviewing airspace restrictions, understanding the aircraft's configuration and performance limitations, and assessing the initial commanded IM Speed. In addition to the initial validity check, the SafeRoute+ equipment will assess the feasibility of time-based Cross clearances; however, the flight crew will assess the overall acceptability based on current conditions and their knowledge of the aircraft and airspace.
- Notify ATC if unable to perform the IM operation and specify the reason.

Figure 3-4. SafeRoute+ MCDU Spacing Page

ATC will provide the missing information or repeat the IM clearance, as requested. ATC will cancel IM and provide other instructions, if necessary, if the flight crew is unable to initiate IM. Depending on the reasons, ATC may re-enter pre-initiation (see Section 3.1.1) after taking other actions or re-assessing the traffic situation.

3.1.3 Execution

The execution phase begins when the IM Aircraft flight crew selects "EXECUTE" on the Spacing page in the SafeRoute+ equipment and implements the first IM Speed.

Figure 3-5 shows the IM Speed (otherwise known as the IM Command Speed) in the upper left corner of the AGD (labeled CMD SPD). As the operation progresses, the flight crew continues to implement new IM speeds presented on the AGD, assessing that each is safe and acceptable to implement in the current conditions.

Figure 3-5. SafeRoute+ AGD

The flight crew is expected to follow the IM Speeds except when operational limitations exist. If operational constraints result in the flight crew being unable to follow the IM Speed, the flight crew will maintain their current speed and advise ATC. The flight crew will monitor SafeRoute+ equipment for system notifications and will notify ATC if at any point they are unable to continue the IM operation. The flight crew will also monitor the aircraft's position relative to the PCP, if issued, preparing to resume published speeds or receive ATC instruction after the operation is completed.

ATC responsibilities do not change when IM is being conducted. The controllers continue to monitor traffic conditions and remain responsible for separation of all aircraft, using existing surveillance capabilities and procedures. If ATC requires spacing other than that provided by IM or is notified by the flight crew of an issue with the IM operation, the controller may cancel (formally or by way of speed instruction) or amend the IM operation. If the controller intends to provide vectors or re-routing to either the IM Aircraft or the Lead Aircraft, the controller will instruct the IM Aircraft flight crew to cancel the active IM operation. Therefore, controllers should have responsibility for both aircraft prior to initiating a routing change of the Lead Aircraft to minimize verbal coordination with the upstream controller. However, if it is necessary to maneuver the Lead Aircraft prior to accepting the IM Aircraft, the controller will inform the upstream controller with the IM Aircraft of the control action with the Lead Aircraft. Similarly, if an operation is canceled and the Lead Aircraft has already been handed off, the canceling controller will coordinate with the appropriate downstream controller to remove any status information from the data block.

The controller may also adjust the spacing by amending the IM ASG. For example, the controller may need to create space for an internal departure or to adjust the time-based ASG based on schedule changes for a new downstream MRP. Similarly, the controller may extend or shorten the duration of the IM operation by amending the PCP whether previously issued or not.

When metered aircraft cross a freeze horizon for a downstream MRP, the schedules are re-frozen and the sequence or ASG may change for the IM Aircraft. The controller should re-confirm the Lead Aircraft and ASG for any IM Aircraft either by checking with the area supervisor or by checking the aircraft information on the area monitor (see Section 3.1.1). If the sequence has changed and there is a new Lead Aircraft, the controller will cancel the active IM operation. If the ASG has changed based on the new TBFM schedule, the controller will amend the IM clearance to reflect the spacing goal. Similarly, controllers should confirm IM operations when TBFM reschedule or re-sequence events occur and cancel or amend IM clearances, as desired.

The controller will communicate the amended clearance element (ASG or PCP) to the IM Aircraft flight crew.

The IM Aircraft flight crew will acknowledge the amendment and request any clarifications, if needed. With any amendment, the flight crew will need to cancel the active clearance by selecting "TERMINATE" on the MCDU Spacing page and enter the amended information. The flight crew will then confirm the acceptability of the updated IM operation, as indicated in Section 3.1.2, prior to execution. If unable to execute, the flight crew will notify ATC.

Otherwise, the IM Aircraft flight crew selects “EXECUTE” on the Spacing page and implements the new IM Speed.

At any time, ATC may request a current spacing report from the IM Aircraft flight crew (see Section 3.2.6). The flight crew will respond with the current spacing as displayed on the AGD

(see

Figure 3-5).

When checking in with a new ZAB sector, the IM Aircraft flight crew will indicate they are actively performing IM and identify the Lead Aircraft. This flight crew self-reporting, combined with pre-defined IM operations and fourth line data entries, should preclude the need for specific controller-to-controller communication of IM status on hand-off. However, if for any reason either controller believes additional coordination is necessary, they may do so.

ATC also monitors both the IM Aircraft and Lead Aircraft position with respect to the PCP and/or the Air Route Traffic Control Center (ARTCC) boundary. IM operations without PCPs or with PCPs outside of ZAB airspace will require the controller to identify the how and when to cancel the operation prior to hand-off of the lead aircraft to another ARTCC.

3.1.4 Cancellation

Under nominal conditions the IM operation will end with a controller speed instruction; alternatively, a controller may identify a PCP as part of the IM clearance at issuance or as an amendment. Upon reaching the PCP, the SafeRoute+ equipment cancels the IM operation, discontinues displaying IM Speeds, and provides a “SPACING TERMINATED” advisory to the flight crew. The flight crew will then resume non-IM operations, following published or ATC-assigned speeds.

During the AIRS Evaluation, controllers may define IM operations with PCPs outside of ZAB airspace (see scenarios in Section 4). In this case, the controller must cancel the IM operation

prior to handing off aircraft to the next facility. There may be other reasons ATC decides to cancel IM operations prior to the PCP. In all cases, ATC will notify the IM Aircraft flight crew of IM cancellation and issue alternate speed instructions. The flight crew will discontinue flying IM Speeds and cancel the IM operation upon receiving ATC speed or vector instructions.

The IM Aircraft flight crew will notify ATC "Unable Spacing" only in the case of an off-nominal or non-normal condition in which the flight crew can no longer follow IM Speeds. Depending on the circumstances, the flight crew may be assisted in this determination by notifications from the SafeRoute+ equipment. ATC will then cancel the IM clearance and issue alternate control instructions.

The IM Aircraft flight crew will acknowledge ATC's notification of cancellation and cancel the operation in the SafeRoute+ equipment using the "TERMINATE" button on the MCDU.

Regardless of why an IM operation is canceled, the controller will remove all indications from ERAM (e.g., "L" and "T" in the data blocks) for the canceled operation.

3.2 Phraseology

For the duration of this operational evaluation, specific phraseology is used by ATC and the IM Aircraft flight crew as part of the IM operation. Controllers are expected to use aircraft callsigns as normal when identifying the Lead Aircraft in the IM clearance, however controllers and flight crews may choose to use a phonetic version of the Lead Aircraft identification if desired (e.g., they may say "U-A-L" or "Uniform Alpha Lima" instead of "United"). Variations are therefore used in the sample phrases presented. Additionally, because the AIRS Evaluation will use waypoints commonly used for routing aircraft in ZAB, controllers are expected use the waypoint name (e.g., Gila Bend) in IM clearances rather than phonetic versions of the identifier (e.g., G-B-N); however, flight crews are also expected to request clarification or confirmation if they are unfamiliar or uncertain about the intended waypoint.

The following conventions are used in defining the I-IM phraseology.

- Words in all capital letters (all caps) are stated as shown
- Terms in italics in parentheses are variables to be replaced with the appropriate values specific to the individual instance
- Words in brackets with "{optional}" at the end are all optional
    - Words in all caps inside of brackets are stated as shown when the option is exercised
    - Terms in italics in parentheses inside of brackets are variables to be replaced appropriately when the option is exercised

3.2.1 IM Clearance Readiness

Controllers may deem it desirable to advise the flight crew of an impending IM clearance and may choose to use an advanced organizer. For example:

- ATC Message: (*IM Aircraft call sign*) SPACING CLEARANCE, ADVISE READY TO COPY
- Sample: "*American 755, spacing clearance, advise ready to copy*"
- Flight Deck Message: *"*(*ATC Facility*), (*Ownship call sign*), READY TO COPY*"*
- Sample: *"Albuquerque Center, American 755, ready to copy"*

3.2.2 IM Clearance Issuance

The following phraseology will be used when issuing an IM clearance. Controllers may choose to include a PCP as part of the clearance and may choose to indicate that the instruction is a spacing (IM) clearance at the start of the clearance.

Cross Clearance:

- ATC Message: (*IM Aircraft call sign*) [SPACING CLEARANCE {optional}] CROSS (*Crossing Point*) (*Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*), [CANCEL AT (*Planned Cancellation Point)* {optional}]
- Sample: *"American 755, cross SLIDR eight miles behind United 345"*
- Sample: *"American 755, cross SLIDR eight miles behind United 345, cancel at HOMRR"*

Maintain Clearance:

- ATC Message: (*IM Aircraft call sign*) [SPACING CLEARANCE {optional}] MAINTAIN (*Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*), [CANCEL AT (*Planned Cancellation Point)* {optional}]
- Sample: *"American 755, maintain eighty-two seconds behind United 345"*
- Sample: *"American 755, maintain eighty-two seconds behind United 345, cancel at BRDEY"*

3.2.3 IM Clearance Acceptance

Upon receipt of the IM clearance, the flight crew will acknowledge the clearance through a read-back, using the following phraseology.

Cross Clearance without PCP:

- Flight Deck Message: (*Ownship call sign*) CROSS (*Crossing Point*) (*Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*)
- Sample: *"American 755, cross SLIDR eight miles behind Uniform Alpha Lima 345"*

Maintain Clearance with optional PCP:

- Flight Deck Message: (*Ownship call sign*) MAINTAIN (*Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*) CANCEL AT (*Planned Cancellation Point*)
- Sample: *"American 755, maintain eighty-two seconds behind U-A-L 345, cancel at BRDEY"*

3.2.4 IM Clearance Amendment

ATC may issue a clearance amendment for the ASG and/or the PCP; this may include issuance of a PCP not previously provided with the IM clearance. The flight crew will acknowledge the amended clearance. Alternatively, ATC may choose to issue a new clearance as described in Section 3.2.2; a new clearance may be appropriate if aircraft are re-routed to a new CP or if multiple clearance elements change.

Amended ASG for Cross Clearance:

- ATC Message: (*IM Aircraft call sign*) [AMEND SPACING {optional}], CROSS (*Crossing Point*) (*New Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*)
- Sample: *"American 755, amend spacing, cross SLIDR eight miles behind U-A-L 345"*
- Flight Deck Message: (*Ownship call sign*) CROSS (*Crossing Point*) (*New Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*)
- Sample: *"American 755, cross SLIDR eight miles behind Uniform Alpha Lima 345"*

Amended ASG for Maintain Clearance:

- ATC Message: (*IM Aircraft call sign*) [AMEND SPACING {optional}], MAINTAIN (*New Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*)
- Sample: *"American 755, amend spacing, maintain eighty-two seconds behind U-A-L 345"*
- Flight Deck Message: (*Ownship call sign*) MAINTAIN (*New Assigned Spacing Goal*) BEHIND (*Lead aircraft call sign*)
- Sample: *"American 755, maintain eighty-two seconds behind U-A-L 345"*

Amended PCP for Maintain Clearance:

- ATC Message: (*IM Aircraft call sign*) CANCEL SPACING AT (*New Planned Cancellation Point*)
- Sample: *"American 755, cancel spacing at DRRVR"*
- Flight Deck Message: *(Ownship call sign)* CANCEL spacing AT *(Planned Cancellation Point)*
- Sample: *"American 755, cancel at DRRVR"*

3.2.5 IM Status Reporting

Note: ZAB has indicated that they initially want this communication from the pilots on check-in if they are on an active IM clearance.

Upon initial contact, the flight crew will advise ATC of an active IM clearance. This information is in addition to any other required information.

- Flight Deck Message: (*ATC facility*) (*Ownship call sign*) (*altitude*) SPACING BEHIND (*Lead aircraft call sign*)
- Sample: *"Albuquerque Center, American 755, flight level three six zero, spacing behind U-A-L 345"*

3.2.6 IM Spacing Report

There may be times during the operation when ATC desires the flight crew to report on their current IM spacing. If ATC requests a current spacing report, the flight crew will acquire the information from the AGD and report to ATC.

- ATC Message: (*IM Aircraft call sign*) SAY CURRENT SPACING
- Sample: "*American 755, say current spacing"*
- Flight Deck Message: (*Ownship call sign*) CURRENT SPACING IS (*current spacing in time or distance*)
- Sample: *"American 755, current spacing is seventy-eight seconds"*

There may also be times when ATC desires the flight crew to report on their assigned IM spacing.

- ATC Message: (*IM Aircraft call sign*) SAY ASSIGNED SPACING
- Sample: "*American 755, say assigned spacing"*
- Flight Deck Message: (*Ownship call sign*) ASSIGNED SPACING IS (*assigned spacing goal in time or distance*)
- Sample: *"American 755, assigned spacing is eighty-two seconds"*

3.2.7 Descend-Via Clearance during IM Operation

If ATC issues a "Descend-Via[4]" clearance to an active IM Aircraft, the flight crew shall comply with procedural speeds unless instructed to comply with the assigned spacing. If controllers believe there may be any ambiguity for the flight crew, they may preface the "Descend-Via" instruction with an explicit cancellation of the IM operation (i.e., "cancel spacing") to ensure the flight crew complies with the procedural speeds on the STAR.

To have flight crews comply with the procedural speeds on the STAR (i.e., canceling the IM operation):

- ATC Message: (*IM Aircraft call sign*) [CANCEL SPACING {optional}], DESCEND VIA (*STAR name, number, and runway transition*)
- Sample: *"American 123, cancel spacing, descend via the EAGUL Six arrival, Runway 26 transition"*
- Sample: *"American 123 descend via the EAGUL Six arrival, Runway 26 transition"*

[4] An abbreviated ATC clearance that requires compliance with a published procedure lateral path and associated speed restrictions and provides a pilot-discretion descent to comply with published altitude restrictions.

Alternatively, the controller may prefer that the flight crew continue the spacing operation and follow IM Speeds. A cancelation point may be communicated with this instruction, which instructs the flight crew to meet procedural speeds only after the PCP. To maintain the IM assigned spacing goal:

- ATC Message: (IM Aircraft call sign) DESCEND VIA (*STAR name and runway transition*) EXCEPT MAINTAIN SPACING [UNTIL (*Planned Cancellation Point)* THEN (*speed instruction)* {optional}]
- Sample: "*American 123, descend via the EAGUL Six arrival, Runway 26 transition, except maintain spacing"*

After this notification, the IM Aircraft flight crew is expected to acknowledge the notification.

- Flight Deck Message: (*Ownship call sign*) [CANCEL SPACING {optional}], DESCEND VIA (STAR name and number)
- Sample: "*American 123, descend via the EAGUL Six arrival, Runway 26 transition"*

or

- Flight Deck Message: (*Ownship call sign*), DESCEND VIA (*STAR name and runway transition*) EXCEPT (*restriction*)
- Sample: "*American 123, descend via the EAGUL Six arrival, Runway 26 transition, except maintain spacing"*

3.2.8 IM Cancellation Initiated by ATC

ATC may cancel an IM operation at any point by issuing a speed or heading instruction. ATC will notify the IM Aircraft flight crew.
(Note: Any speed or heading instruction by ATC automatically cancels an existing IM clearance.)

- ATC Message: (*IM Aircraft call sign*) [CANCEL SPACING {optional}] (*instructions as necessary*)
- Sample: "*American 755, resume published speeds*"
- Sample: "*American 755, maintain three one zero knots*"
- Sample: "*American 755, reduce speed to Mach .75*"

After this notification, the IM Aircraft flight crew is expected to acknowledge the notification.

- Flight Deck Message: (*Ownship call sign*) [CANCEL SPACING {optional}] (*instructions as necessary*)
- Sample: "*American 755, resume published speeds*"
- Sample: "*American 755, maintain three one zero knots*"
- Sample: "*American 755, reduce to Mach .75*"

ATC may also cancel an IM operation by issuing a downstream PCP followed by a speed instruction.

- ATC Message: (*IM Aircraft call sign*) CANCEL SPACING AT (*PCP*) THEN (*speed instruction*)
- Sample: "*American 755, cancel spacing at HOMRR then resume published speeds"*
- Flight Deck Message: (*Ownship call sign*) CANCEL SPACING AT (*Planned Cancellation Point*) THEN (*speed instruction*)
- Sample: "American 755, cancel spacing at HOMRR then resume published speeds"

3.2.9 IM Cancellation Initiated by IM Aircraft

When the IM Aircraft flight crew desires to end IM operations[5] at any point other than the PCP, including at initiation, they will notify ATC.

- Flight Deck Message: (*ATC facility*) (*Ownship call sign*) UNABLE SPACING [(*state reason)* {optional}]
- Sample: "*Albuquerque Center, American 755 unable spacing*"

After this notification, ATC is expected to acknowledge the notification and provide a speed instruction.

- ATC Message: (*IM Aircraft call sign*) ROGER (*instructions as necessary*)
- Sample: "*American 755, roger, resume published speeds*"
- Sample: "*American 755, roger, resume normal speed*"
- Sample: "*American 755, roger, maintain Mach .75*"

[5] The IM Aircraft flight crew may elect to end the IM operation due to speed commands outside of the aircraft performance envelope, turbulence, or other factors affecting normal flight.

4 OPERATIONAL SCENARIOS

These example scenarios describe ZAB IM operations using distance-based ASGs for overflight traffic landing at Dallas-Fort Worth International Airport (KDFW) and San Diego International Airport (KSAN) as well as time-based based ASGs for arrivals KPHX on the EAGUL6 (northeast) and PINNG1 (southeast) arrivals. Although these scenarios are depicted as nominal operations through the planned completion, any controller actively managing the IM Aircraft may cancel the IM operation if the flight crew reports unable, the controller's objectives change, another technique is preferred or necessary, or continuation of the IM operation is not desired for any other reason. The following apply across all the scenarios:

- IM is a technique to help the controller to achieve desired spacing; the use of IM does not change controller responsibilities with respect to non-IM traffic. Controllers are required to monitor and maintain spacing and separation for all traffic under their control.
- All ZAB controllers are expected to comply with TMIs (e.g., 10 MIT over the waypoint INK for KDFW bound flights) whether they use IM or some other technique.
- Controllers may use an advanced organizer (i.e., expect clearance) to prepare the flight crew for a pending IM clearance. Use of this option is not depicted in the scenarios.
- IM operations must be contained within ZAB airspace and ZAB controllers must ensure cancellation of the IM operation and remove data block notations prior to handoff of each aircraft to P50 or another center.

Additionally, although there are several options for controllers to determine a time-based ASG (see Section 3.1.1), the time-based scenarios depict the option where the controller and area supervisor coordinate the IM pair and ASG derived from the SWIM Tool.

4.1 Scenario # 1: MIT for Overflights to KDFW

Scenario #1 describes the application of IM to achieve a specific MIT on overflights headed eastbound to KDFW as well as the controller issuance of the optional PCP. Figure 4-1 illustrates the aircraft, routes, IM special points, and ZAB sectors involved in the scenario.

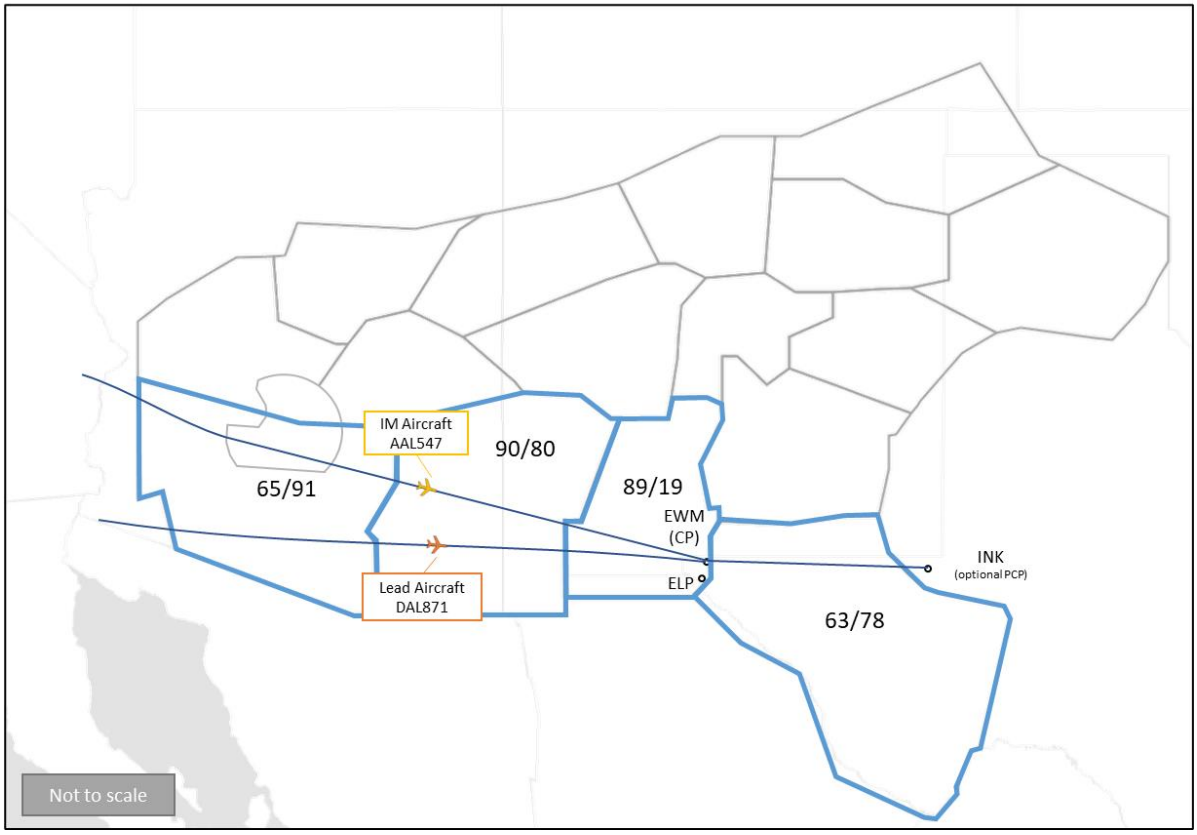

Figure 4-1. Scenario #1 - MIT for Overflights to KDFW

Table 4-1 summarizes the responsibilities of each ZAB sector expected to participate in this scenario.

Table 4-1. Scenario #1 Sector Responsibilities

Sector	Responsibilities
ZAB-91	➢ Deconflict traffic prior to handoff to ZAB-90/80
ZAB-90/80	➢ Assess traffic and initiate IM if appropriate ➢ Monitor spacing and separation prior to handoff to ZAB-89/19 ➢ Cancel IM early if necessary
ZAB-89/19	➢ Accept IM pair from ZAB-90/80 ➢ Monitor spacing and separation prior to handoff to ZAB-63/78 ➢ Cancel IM early if necessary
ZAB-63/78	➢ Accept IM pair from ZAB-89/19 ➢ Monitor spacing and separation prior to handoff to ZFW ➢ Cancel IM early if necessary ➢ Cancel IM prior to handoff of Lead Aircraft to ZFW

Table 4-2 lists the key parameters for the IM operation illustrated in this scenario.

Table 4-2. Scenario #1 Key IM Parameters

Parameter	Scenario Details	Notes
Nominal MIT	10 NM	The MIT associated with a specific TMI will be posted on the Enhanced Status Information System (ESIS) boards.
IM Special Points	CP: Newman (EWM) Optional PCP: Wink (INK)	The PCP is not used in this scenario.
Aircraft	IM Aircraft: AAL547 Lead Aircraft: DAL871	AAL547 is a suitably equipped and identified A321 aircraft.

There are several options controllers have when using IM to achieve the MIT for KDFW-bound traffic, not all of which are included in the scenario. These include the following:

- A Maintain clearance may be used if the aircraft are already on the same route; a Cross clearance may be used after both aircraft are direct to EWM (the Cross clearance is illustrated in Scenario #1).
- The controller has options to provide a speed instruction to AAL547 after cancellation – "resume normal speed" is used in Scenario #1.

4.1.1 Pre-initiation

A TMI is established for ZAB delivery of KDFW-bound traffic and the MIT requirement will be coordinated as usual on the ESIS boards (in this scenario 10 MIT over INK). During the AIRS Evaluation and under current conditions, IM is established as a suitable tool for controllers to achieve the required MIT. Also, though ZAB-90/80 may not normally have knowledge of the KDFW TMI, for the AIRS Evaluation ZAB-90/80 will be included in the TMI (notified) to facilitate earlier initiation of IM when practical.

The ZAB-90/80 controller recognizes that the KDFW TMI applies to an AAL A321 (AAL547) and there is an opportunity to use IM to achieve the desired 10 NM spacing.

The controller identifies the appropriate Lead Aircraft in the sequence and ensures both aircraft are direct to EWM and then INK. The controller defines the following IM clearance elements:

- Trail Aircraft = AAL547
- Lead Aircraft = DAL871

- ASG = 10 NM
- Clearance Type = Cross
- CP = EWM

The ZAB-90/80 controller refers to an IM quick reference card to ensure that all applicable initiation criteria are satisfied prior to initiating the IM operation. Figure 4-2 illustrates what an IM quick reference card might look like; the specific card will be designed and produced by ZAB.

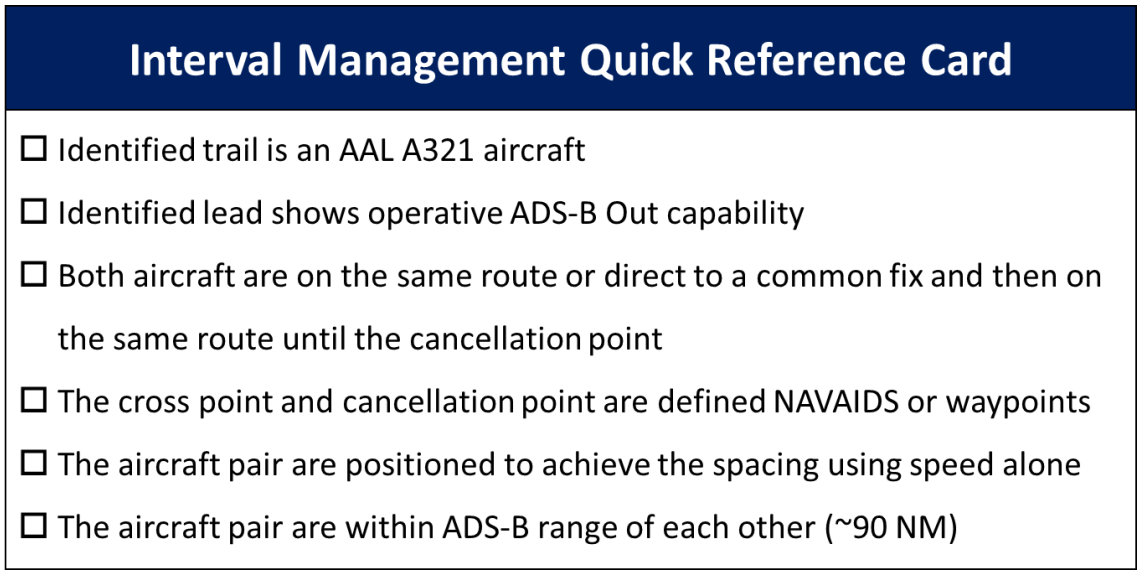

Figure 4-2. IM Quick Reference Card

4.1.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied, the controller transmits the clearance to the AAL aircraft.

> **ZAB ATC:** "American five forty-seven cross EWM one zero miles behind Delta eight seventy-one"
>
> **AAL547:** "American five forty-seven roger cross EWM one zero miles behind Delta eight seventy-one"

The ZAB-90/80 controller records that AAL547 is an active Trail Aircraft in the fourth line of AAL547's data block as shown in Figure 4-3. Although the ASG, CP, and PCP are pre-defined IM parameters, the controller may choose to record these clearance elements for later reference. The controller records that DAL871 is the Lead Aircraft in the fourth line of DAL871's data block.

Figure 4-3. ERAM 4th Line Annotations of IM Aircraft (left) and Lead Aircraft (right)

The AAL547 flight crew assesses their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The AAL547 flight crew inputs the IM clearance parameters into the avionics, performs a cross-cockpit verification of the data entry, and confirms the acceptability of the IM operation.

4.1.3 Execution

The AAL547 flight crew flies the IM Command Speeds.

The ZAB-90/80 controller monitors the speed of AAL547 and spacing with DAL871 and other aircraft in the sector. The ZAB-90/80 controller may adjust the speed or vector the following aircraft to accomplish the required spacing behind AAL547.

The AAL547 flight crew continues to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitors for other IM-related notifications.

As AAL547 progresses, ZAB-90/80 initiates the hand-off to ZAB-89/19. The AAL547 flight crew checks in on the next frequency and communicates that they are providing spacing behind lead aircraft DAL871.

> **AAL547:** "Albuquerque Center, American five forty-seven, flight level three three zero spacing behind Delta eight seventy-one"
>
> **ZAB ATC:** "American five forty-seven roger"

The ZAB-89/19 controller monitors the speed of AAL547 and spacing with DAL871 and other aircraft in the sector, adjusting the speed and/or routing of non-IM Aircraft as necessary.

Similarly, downstream ZAB-89/19 initiates the hand-off to ZAB-63/78. The AAL547 flight crew checks in, self-reporting the active IM operation to ZAB-63/78.

The ZAB-63/78 controller monitors the speed of AAL547 and spacing with DAL871 and other aircraft in the sector until such time as they decide to cancel the operation.

4.1.4 Cancellation

Since IM operations are only authorized in ZAB airspace for the AIRS Evaluation, the ZAB-63/78 controller removes any IM notations from the fourth line of the Lead Aircraft's (DAL871) data block prior to handoff to DAL871 to ZFW.

The ZAB-63/78 controller also cancels the IM clearance and assigns AAL547 a speed to fly prior to AAL547 leaving ZAB airspace. The ZAB-63/78 controller removes all recorded IM clearance information from AAL547 data block and hands off AAL547 to ZFW.

> **ZAB ATC:** "American five forty-seven resume normal speed, contact Forth Worth Center one three two point zero seven"
>
> **AAL547:** "American five forty-seven roger resume normal speed, contact Fort Worth Center one three two point zero seven"

4.2 Scenario # 2: MIT for Overflights to KSAN

Scenario #2 describes the application of IM to achieve a specific MIT to comply with a TMI for flights westbound to San Diego (KSAN). Figure 4-4 illustrates the aircraft, routes, IM special points, and ZAB sectors involved in the scenario.

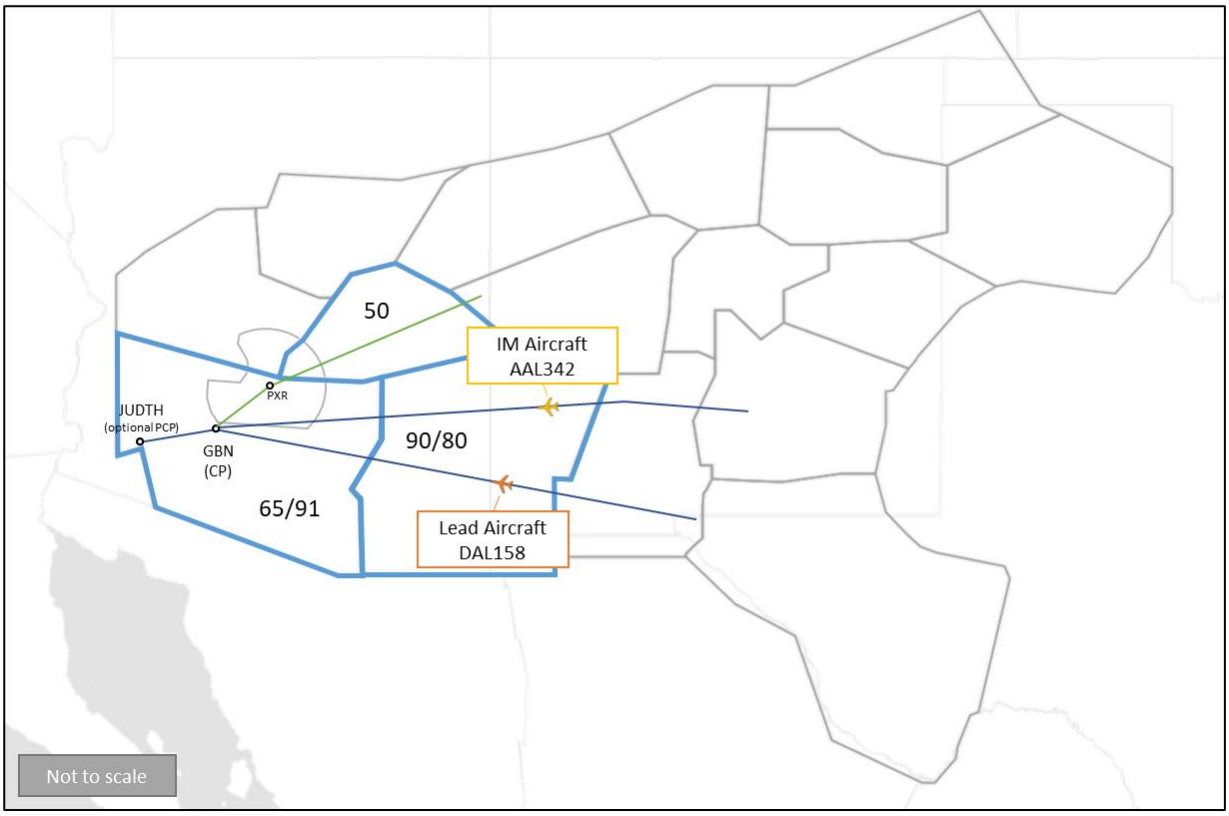

Figure 4-4. Scenario #2 – MIT for Overflights to KSAN

Table 4-3 summarizes the responsibilities of each ZAB sector expected to participate in this scenario. Sectors are not expected to initiate IM with a lead in another sector; for example, ZAB-50 may initiate IM with two aircraft in ZAB-50 headed over GBN but will not pair an IM Aircraft with a Lead Aircraft in Sector 90/80 or 91. Similarly, ZAB-90/80 will only initiate IM with a pair in ZAB-90/80.

Table 4-3. Scenario #2 Sector Responsibilities

Sector	Responsibilities
ZAB-50	➢ Assess traffic and initiate IM if appropriate ➢ Monitor spacing and separation prior to handoff to ZAB-91 ➢ Cancel IM early if necessary
ZAB-90/80	➢ Assess traffic and initiate IM if appropriate ➢ Monitor spacing and separation prior to handoff to ZAB-91 ➢ Cancel IM early if necessary

Sector	Responsibilities
ZAB-91	➢ Accept IM pair from ZAB-50 or ZAB-90/80 ➢ Monitor spacing and separation ➢ Cancel IM early if necessary ➢ Ensure cancellation of IM in ZAB-91 at PCP prior to handoff to Los Angeles ARTCC (ZLA)

Table 4-4 lists the key parameters for the IM operation illustrated in this scenario.

Table 4-4. Scenario #2 Key IM Parameters

Parameter	Scenario Details	Notes
Nominal MIT	15 NM	The MIT associated with a specific TMI will be posted on the ESIS boards.
IM Special Points	CP: Gila Bend (GBN) Optional PCP: Judith (JUDTH)	GBN is appropriate for either ZAB-50 or ZAB-90/80; only ZAB-90/80 initiation is demonstrated in scenario #2. The PCP is not used in this scenario.
Aircraft	IM Aircraft: AAL342 Lead Aircraft: DAL158	AAL342 is a suitably equipped and identified A321 aircraft.

Controllers have several options controllers when using IM to achieve the MIT for KSAN-bound traffic, not all of which are included in the scenario. These include the following:

- Controllers may provide "maintain current speed and advise" instruction at initiation, cancellation, or both (at cancellation is used in Scenario #2).
- ZAB-91 controller may amend ASG to create a gap for departures from KPHX (amendments are used in Scenario #3).
- A Maintain clearance may be used if the aircraft are already on the same route; a Cross clearance may be used after both aircraft are direct to GBN (the Cross clearance is illustrated in Scenario #2).

4.2.1 Pre-initiation

A TMI is established for ZAB delivery of KSAN-bound traffic and the MIT requirement will be coordinated as usual on the ESIS boards (in this scenario 15 MIT over GBN). During the AIRS Evaluation and under current conditions, IM is established as a suitable technique for controllers achieve the required MIT.

The ZAB-90/80 controller recognizes that a KSAN bound AAL A321 (AAL342) is in the KSAN TMI and is a candidate to use IM to achieve the desired 15 NM spacing.

The ZAB-90/80 controller identifies the appropriate Lead Aircraft in the sequence to KSAN and ensures both aircraft are direct to GBN and then on the same route (either jetway or direct) to JUDTH. The controller defines the following IM clearance elements:

- Trail Aircraft = AAL342
- Lead Aircraft = DAL158
- ASG = 15 NM
- Clearance Type = Cross
- CP = GBN

The ZAB-90/80 controller refers to an IM quick reference card to ensure that all applicable initiation criteria are satisfied prior to initiating the IM operation.

4.2.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied the controller transmits the clearance to the AAL aircraft. The ZAB-90/80 controller communicates the IM clearance to AAL342.

> **ZAB ATC:** "American three forty-two cross GBN one five miles behind Delta one fifty-eight"
>
> **AAL342:** "American three forty-two roger cross GBN one five miles behind Delta one fifty-eight"

The ZAB-90/80 controller records that AAL342 is an active Trail Aircraft in the fourth line of AAL342's data block. Although the ASG, CP, and PCP are pre-defined IM parameters, the controller may choose to record these clearance elements for later reference. The controller records that DAL158 is the Lead Aircraft in the fourth line of DAL158's data block.

The AAL342 flight crew assesses their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The AAL342 flight crew inputs the IM clearance parameters into the avionics, performs a cross-cockpit verification of the data entry, and confirms the acceptability of the IM operation.

4.2.3 Execution

The AAL342 flight crew flies the IM Command Speeds.

The ZAB-90/80 controller monitors the speed of AAL342 and spacing with DAL158 and other aircraft in the sector. The ZAB-90/80 controller may adjust the speed or vector the following aircraft to accomplish the required spacing behind AAL342.

The AAL342 flight crew continues to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitors for other IM-related notifications.

As AAL342 progresses, ZAB-90/80 initiates the hand-off to ZAB-91. The AA342 flight crew checks in on the next frequency and communicates that they are providing spacing behind lead aircraft DAL158.

> **AAL342:** "Albuquerque Center, American three forty-two, flight level three three zero spacing behind Delta one fifty-eight"
>
> **ZAB ATC:** "American three forty-two roger"

The ZAB-91 controller monitors the speed of AAL342 and spacing with DAL158 and other aircraft in the sector until they decide to cancel the operation prior to or when AAL342 reaches JUDTH.

4.2.4 Cancellation

Prior to AAL342 leaving ZAB airspace, the ZAB-91 controller will ensure the IM clearance cancels at or before JUDTH and assign AAL342 a speed to fly. Prior to AAL342 reaching JUDTH, the ZAB-91 controller will issue a speed instruction.

> **ZAB ATC:** "American three forty-two at JUDTH maintain current speed and advise"
>
> **AAL342:** "American three forty-two roger at JUDTH maintain current speed and advise"

When AAL342 reaches JUDTH, the flight crew will advise ATC as instructed.

> **AAL342:** "American three forty-two at JUDTH current speed Mach point seven niner"
>
> **ZAB ATC:** "American three forty-two roger maintain Mach point seven niner"
>
> **AAL342:** "American three forty-two roger maintain Mach point seven niner"

The ZAB-91 controller removes all recorded IM clearance information from the AAL342 and DAL158 data blocks. The ZAB-91 controller enters the assigned speed in the AAL342 data block and hands off AAL342 to ZLA.

4.3 Scenario # 3: PINNG Arrivals to KPHX

Scenario #3 describes the application of IM to arrivals on the PINNG1 STAR into KPHX using time-based ASGs from TBFM, including amending an IM clearance when aircraft schedules are re-frozen for the Meter Fix Arc (MFA) and the aircraft Scheduled Times of Arrival (STAs) result in a different ASG for the pair. The scenario incorporates the transition from IM to a Descend Via clearance while maintaining IM Speeds to the KPHX TRACON boundary. Figure 4-5 illustrates the first aircraft pair, routes, IM special points, and ZAB sectors involved in the scenario.

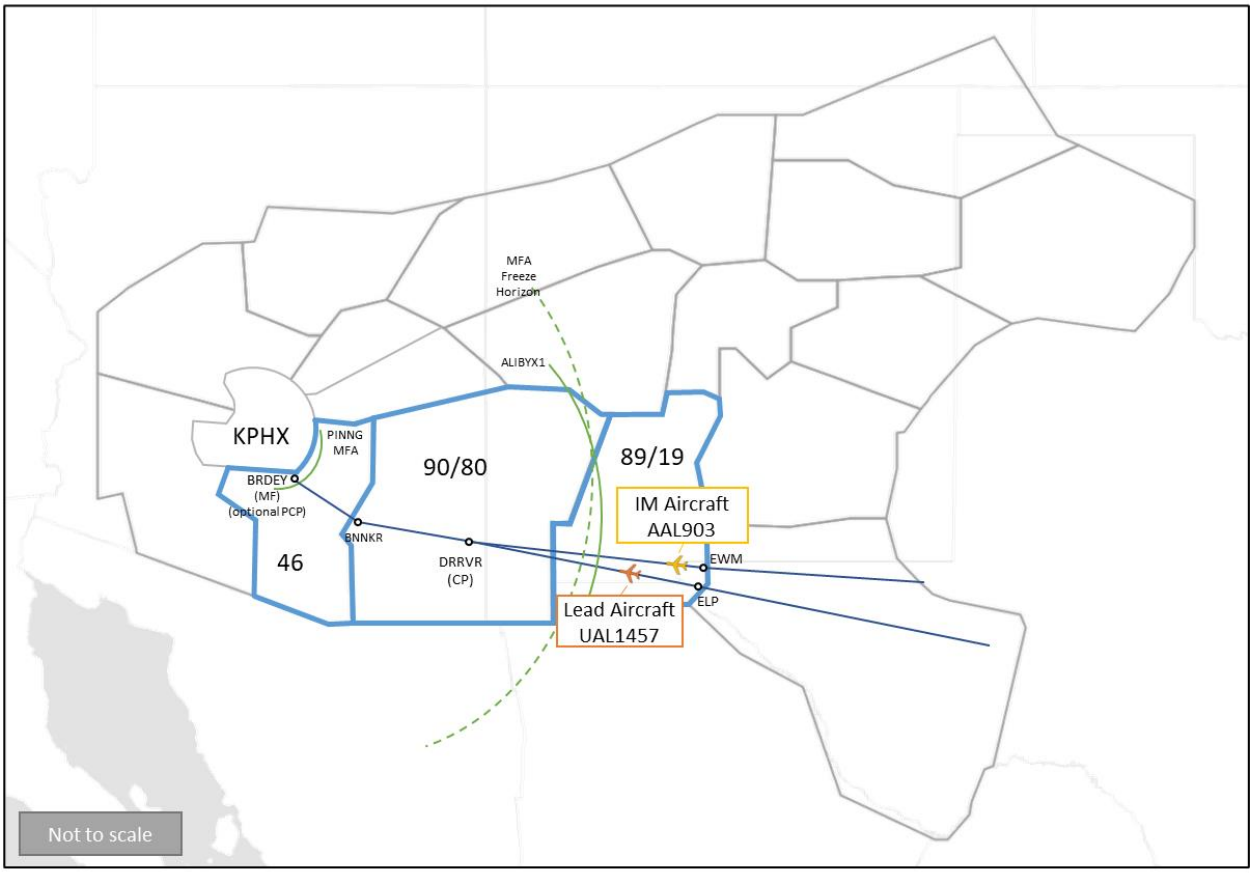

Figure 4-5. Scenario #3 - PINNG Arrivals to KPHX: Pair 1 Initiation

Table 4-5 summarizes the responsibilities of each ZAB sector expected to participate in this scenario.

Table 4-5. Scenario #3 Sector Responsibilities

Sector	Responsibilities
ZAB-89/19	➢ Assess traffic and, if feasible, initiate IM after aircraft pass EWM/ELP and are direct to DRRVR for the PINNG1 arrival ➢ Confirm aircraft pair and ASG with area supervisor ➢ Monitor spacing and separation prior to handoff to ZAB-90/80

Sector	Responsibilities
	➢ Coordinate handoff of IM pair with ZAB-90/80
ZAB-90/80	➢ Accept IM pair from ZAB-89/19 and confirm IM pairs and ASGs for active IM operations received from ZAB-89/19 ➢ Amend or cancel active IM operations that have changed ➢ Assess traffic and initiate IM if appropriate ➢ Confirm aircraft pair and ASG with area supervisor for new IM operations initiated ➢ Monitor spacing and separation prior to handoff to ZAB-46 ➢ Cancel IM early if necessary
ZAB-46	➢ Accept IM pair from ZAB-90/80 ➢ Monitor spacing and separation ➢ Cancel IM early if necessary ➢ Ensure the IM clearance is appropriately canceled, and the IM Aircraft is provided the proper speed instruction for the descent to KPHX

Table 4-6 lists the key parameters for the IM operation illustrated in this scenario.

Table 4-6. Scenario #3 Key IM Parameters

Parameter	Scenario Details	Notes
ASG	Aircraft Pair 1: 82 seconds Aircraft Pair 1 Amendment: 72 seconds Aircraft Pair 2: 75 seconds	The ASG will be sourced from TBFM via the SWIM Tool based on the scheduled arrival times at the meter fix (MF) and meter arc depicted in Figure 4-5. The scenario ASGs are used for illustrative purposes only and may not reflect actual spacing goals based on the differences in TBFM STAs.
IM Special Points	CP: Driver (DRRVR) Optional PCP: Bunker (BNNKR) or Birdy (BRDEY)	The PCP is not used in this scenario.
Aircraft Pair 1	IM Aircraft: AAL903 Lead Aircraft: UAL1457	AAL903 is a suitably equipped and identified A321 aircraft.
Aircraft Pair 2	IM Aircraft: AAL1063 Lead Aircraft: UAL2031	AAL1063 is a suitably equipped and identified A321 aircraft.

There are several options controllers have using IM to support the metering operations into KPHX on the PINNG arrival, not all of which are included in the scenario. These include the following:

- The ZAB-90/80 controller may amend the ASG based on new TBFM STAs (amendments are illustrated in Scenario #3) to BRDEY.
- A Maintain clearance may be used if the aircraft are already on the same route; a Cross clearance may be used after both aircraft are direct to DRRVR (both clearance types are illustrated in Scenario #3).
- BRDEY may be used as a PCP as the last waypoint on the arrival prior to the KPHX TRACON. BNNKR is the first waypoint on the STAR with a speed and altitude constraint and may be used as a PCP for IM. A PCP is not used in Scenario #3, however the operation is canceled by the controller prior to hand-off of the Lead Aircraft to KPHX.

4.3.1 Pre-initiation Pair 1

Aircraft landing at KPHX are established on published routes and are routinely required to be spaced by arrival sector controllers. Spacing requirements may be an MIT restriction or a time restriction. The spacing requirement is provided by the Traffic Management Unit (TMU) and coordinated with affected sectors. In this scenario, metering is in effect and the ZAB controllers understand that time-based ASGs may be used to meet relative spacing objectives for suitably equipped AAL aircraft arriving on the PINNG1 arrival into KPHX.

The area supervisor has the capability to retrieve the time-based ASG from the SWIM Tool. In this scenario, expecting to execute IM operations on arrivals into KPHX, the area supervisors will open an instance of the SWIM Tool for the Meter Fix (BRDEY) as well as the Extended Meter Points (XMP) meter arc (ALIBYX1) to provide pairs and ASGs based on the TBFM schedule (refer to example display in Section 3.1). The time-based ASG is presented for all relevant pairs on the supervisor's computer and is available for relay to the controller with the IM Aircraft.

The ZAB-89/19 controller recognizes that a KPHX bound AAL A321 (AAL903) is a candidate to use IM to achieve the desired spacing on the PINNG1 arrival. The ZAB-89/19 controller coordinates with the southeast supervisor to confirm the appropriate Lead Aircraft in the sequence to KPHX and to retrieve the time-based ASG for ALIBYX1 from the SWIM Tool. After crossing the freeze horizon for the PINNG MFA (see Figure 4-5), either the pair or the ASG may change as the schedules are frozen. If the pair changes, the IM operation will be canceled and new one initiated if desired. If the ASG changes, the ZAB-90/80 controller may amend the IM clearance as depicted in this scenario. In this case, the CP and PCP do not change and are therefore appropriate for the ZAB-89/19 controller to use. In this case, the controller defines the following Cross clearance elements for Pair 1.

- Trail Aircraft = AAL903
- Lead Aircraft = UAL1457
- ASG = 82 seconds

- Clearance Type = Cross
- CP = DRRVR

The ZAB-89/19 controller refers to an IM quick reference card to ensure that all applicable initiation criteria are satisfied prior to initiating the IM operation.

4.3.2 Initiation Pair 1

Once the controller determines the clearance information and all initiating conditions are satisfied, the ZAB-89/19 controller communicates the IM clearance to AAL903.

> **ZAB ATC:** "American nine zero three cross DRRVR eight two seconds behind United fourteen fifty-seven"
>
> **AAL903:** "American nine zero three roger cross DRRVR eight two seconds behind United fourteen fifty-seven"

The ZAB-89/19 controller records that AAL903 is an active Trail Aircraft in the fourth line of AAL903's data block. Since the ASG is not readily available without coordination with the area supervisor and will need to be referenced by the downstream controller, the ZAB-89/19 also records the ASG in the fourth line of AAL903's data block as shown in Figure 4-6. The controller may choose to record the other clearance elements for later reference. The controller records that UAL1457 is the Lead Aircraft in the fourth line of UAL1457's data block.

Figure 4-6. ERAM 4th Line Annotation of IM Aircraft with Time-based ASG

The AAL903 flight crew assesses their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The AAL903 flight crew inputs the IM clearance parameters into the avionics, performs a cross-cockpit verification of the data entry, and confirms the acceptability of the IM operation.

4.3.3 Execution Pair 1

The AAL903 flight crew flies the IM Command Speeds.

The ZAB-89/19 controller monitors the speed of AAL903 and spacing with UAL1457 and other aircraft in the sector. The ZAB-89/19 controller manages the Lead Aircraft (UAL1457) and other

aircraft in the sector to the metering schedule using the delay countdown timer (DCT) and other metering tools in accordance with their normal procedures. IM will ensure the IM Aircraft (AAL903) maintains relative time-spacing behind the Lead Aircraft (UAL1457) based on the ASG derived from the schedule.

The AAL903 flight crew continues to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitors for other IM-related notifications.

As AAL903 progresses, ZAB-89/19 initiates the hand-off to ZAB-90/80. The AAL903 flight crew checks in on the next frequency and communicates that they are providing spacing behind lead aircraft UAL1457.

> **AAL903:** "Albuquerque Center, American nine zero three, flight level two nine zero spacing behind United fourteen fifty-seven"
>
> **ZAB ATC:** "American nine zero three roger"

The ZAB-90/80 controller recognizes AAL903 as an IM Aircraft from the check-in and by observing "T82" in the fourth line of the data block. After AAL903's schedule to the MFA is frozen, the ZAB-90/80 controller coordinates with the southwest area supervisor to confirm the Lead Aircraft and the time-based ASG for the BRDEY from the SWIM Tool. In this case, the Lead Aircraft is still UAL1457, however, the ASG is now 72 seconds.

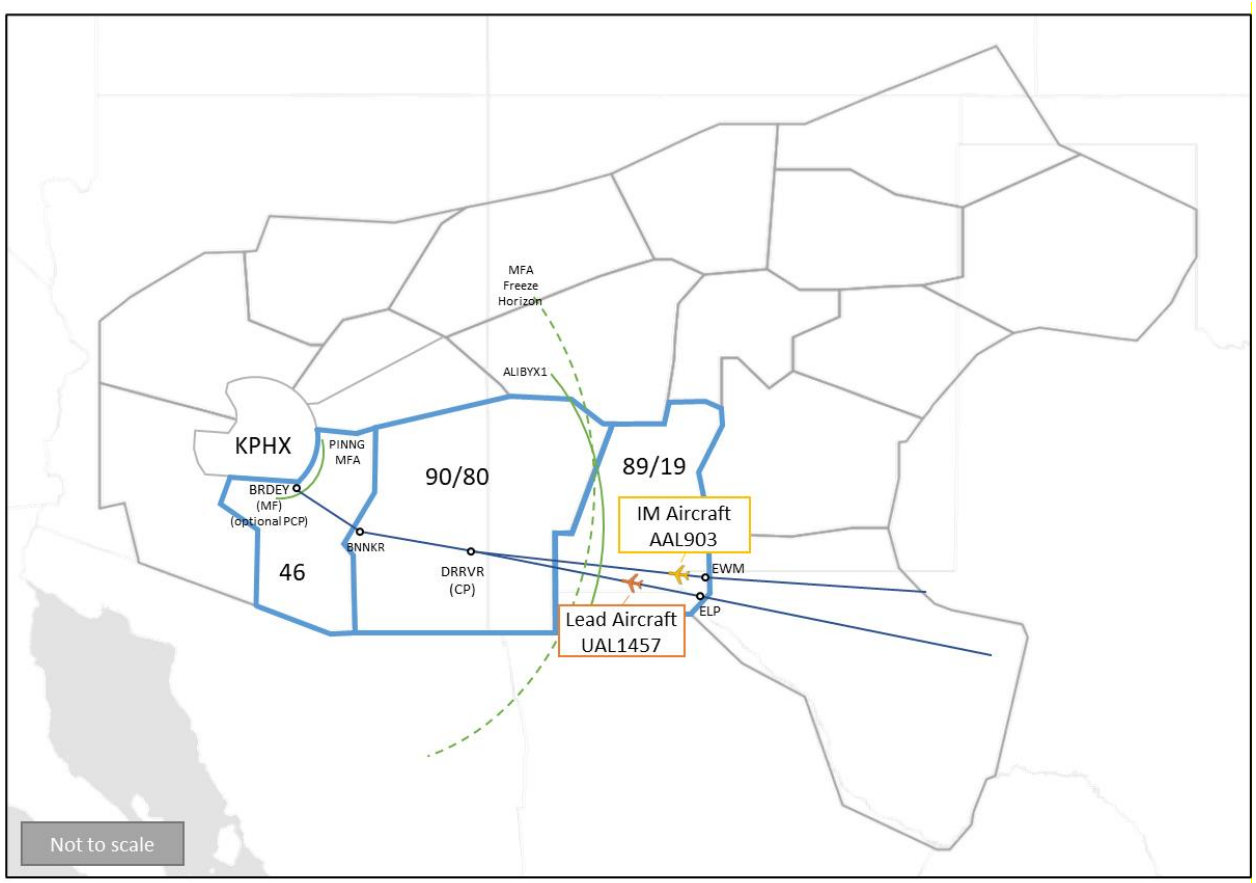

Figure 4-7. Scenario #3 – PINNG Arrivals to KPHX: Pair 1 Amendment

Note: If for any reason, the controller and supervisor determine the sequence at the MF is different (i.e., the lead for AAL903 is no longer UAL1457), the ZAB-90/80 controller will cancel the existing IM clearance and may issue a new IM clearance for AAL903 with the new Lead Aircraft or may issue other instructions to AAL903 to achieve the desired outcome.

The ZAB-90/80 controller issues an amendment to the IM clearance and updates the fourth line of AAL903's data block to reflect the new ASG.

ZAB ATC: "American nine zero three amend spacing, cross DRRVR seven two seconds behind United fourteen fifty-seven"

AAL903: "American nine zero three roger cross DRRVR seven two seconds behind United fourteen fifty-seven"

The AAL903 flight crew re-assesses their IM capability as well as the new ASG and confirms the acceptability of the amended IM operation. The flight crew initiates and the amended operation and continues to implement new IM Speeds and monitor for other IM-related notifications.

The ZAB-90/80 controller monitors the speed of AAL903 and spacing with UAL1457 and other aircraft in the sector. The ZAB-90/80 controller manages the Lead Aircraft (UAL1457) and other aircraft in the sector to the metering schedule using their standard metering tools and maintains appropriate separation with the IM Aircraft (AAL903).

When appropriate, the ZAB-90/80 controller issues a descend via clearance for the PINNG while maintaining IM Speeds. The AAL1063 flight crew will fly IM Speeds and published altitudes.

> **ZAB ATC:** "American nine zero three, descend via the PINNG one arrival, runway two five left transition, except maintain spacing"
>
> **AAL1063:** "American nine zero three, descend via the PINNG one arrival, runway two five left transition, except maintain spacing"

Similarly, downstream, ZAB-90/80 initiates the hand-off to ZAB-46. The AAL903 flight crew checks in, self-reporting the active IM operation to ZAB-46.

The ZAB-46 controller monitors the speed of AAL903 and spacing with UAL1457 and other aircraft in the sector until such time as they decide to cancel the operation AAL903.

4.3.4 Cancellation Pair 1

When UAL1457 reaches BRDEY and prior to hand-off to the KPHX TRACON, the ZAB-46 controller cancels the IM clearance for the PINNG and the AAL903 flight crew will fly published speeds and altitudes.

> **ZAB ATC:** "American nine zero three, resume published speeds, contact Phoenix approach one two four point one"
>
> **AAL903:** "American nine zero three, resume published speeds, contact Phoenix approach one two four point one"

The ZAB-46 controller removes all IM indications in the data blocks of both AAL903 and UAL1457[6]. The AAL903 flight crew cancels the IM operation in the MCDU.

4.3.5 Pre-initiation Pair 2

Later in the shift, the ZAB-89/19 controller recognizes that a KPHX bound AAL A321 (AAL1063) is a candidate to use IM to achieve the desired spacing on the PINNG1 arrival. The ZAB-89/19 controller coordinates with the southeast supervisor to confirm the appropriate Lead Aircraft in the sequence to KPHX and to retrieve the time-based ASG for ALIBYX1 from the SWIM Tool. In this case, the controller defines the following Maintain clearance elements for Pair 2 as the candidate Lead Aircraft (UAL2031) is already on the same route as AAL1063.

- Trail Aircraft = AAL1063

[6] Although fourth line data will not pass to the TRACON, it is best practice to clean up the display and remove indications of operations that have been canceled.

- Lead Aircraft = UAL2031
- ASG = 75 seconds
- Clearance Type = Maintain

The ZAB-89/19 controller refers to an IM quick reference card to ensure that all applicable initiation criteria are satisfied prior to initiating the IM operation.

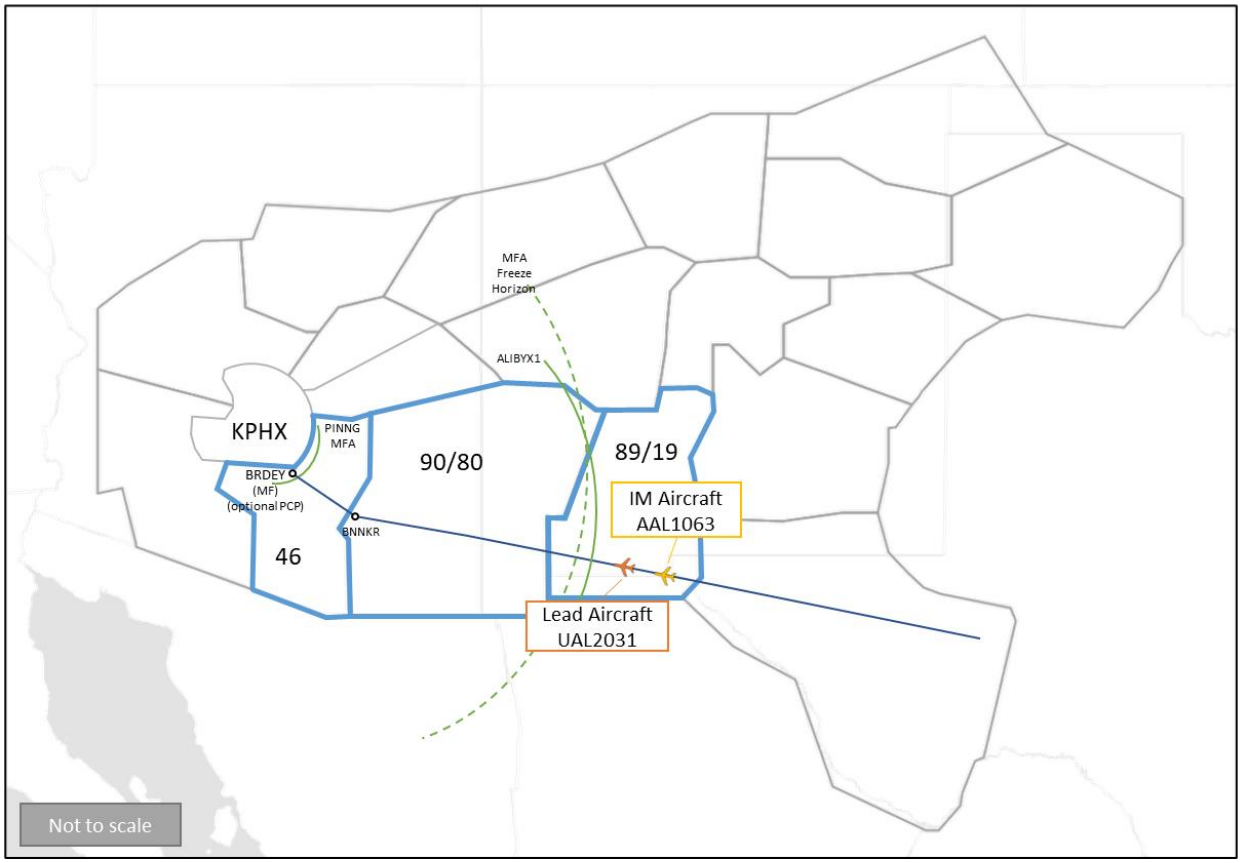

Figure 4-8. Scenario #3 – PINNG Arrivals to KPHX: Pair 2 Initiation

4.3.6 Initiation Pair 2

Once the controller determines the clearance information and all initiating conditions are satisfied, the ZAB-89/19 controller communicates the IM clearance to AAL1063.

> **ZAB ATC:** "American ten sixty-three maintain seven five seconds behind United twenty thirty-one"
>
> **AAL1063:** "American ten sixty-three maintain seven five seconds behind United twenty thirty-one"

The ZAB-89/19 controller records that AAL1063 is an active Trail Aircraft and the ASG (T75) in the fourth line of AAL1063's data block. The controller may choose to record the other clearance elements for later reference. The controller records that UAL2031 is the Lead Aircraft in the fourth line of UAL2031's data block (L).

The AAL1063 flight crew assesses their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The AAL1063 flight crew inputs the IM clearance parameters into the avionics, performs a cross-cockpit verification of the data entry, and confirms the acceptability of the IM operation.

4.3.7 Execution Pair 2

The AAL1063 flight crew flies the IM Command Speeds.

The ZAB-89/19 controller monitors the speed of AAL1063 and spacing with UAL2031 and other aircraft in the sector. The ZAB-89/19 controller manages the Lead Aircraft (UAL2031) and other aircraft in the sector to the metering schedule using their standard metering tools.

The AAL1063 flight crew continues to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitors for other IM-related notifications.

As AAL1063 progresses, ZAB-89/19 initiates the hand-off to ZAB-90/80. The AAL1063 flight crew checks in on the next frequency and communicates that they are providing spacing behind lead aircraft UAL2031.

> **AAL1063:** "Albuquerque Center, American ten sixty-three, flight level two nine zero spacing behind United twenty thirty-one"
>
> **ZAB ATC:** "American ten sixty-three roger"

The ZAB-90/80 controller recognizes AAL1063 as an IM Aircraft from the check-in and by observing "T75" in the fourth line of the data block. After AAL1063's schedule to the MFA is frozen, the ZAB-90/80 controller coordinates with the southwest area supervisor to confirm the Lead Aircraft and the time-based ASG for BRDEY from the SWIM Tool. In this case, the Lead Aircraft and ASG are the same and no additional action is necessary.

The ZAB-90/80 controller monitors the speed of AAL1063 and spacing with UAL2031 and other aircraft in the sector. The ZAB-90/80 controller manages the Lead Aircraft (UAL2031) and other aircraft in the sector to the metering schedule using their standard metering tools.

The ZAB-90/80 controller issues a descend via clearance for the PINNG with the exception to maintain the IM spacing. The AAL1063 flight crew will continue to fly IM Speeds and will comply with procedure altitudes.

> **ZAB ATC:** "American ten sixty-three, descend via the PINNG one arrival, runway two five left transition, except maintain spacing"

AAL1063: “American ten sixty-three, descend via the PINNG one arrival, runway two five left transition, except maintain spacing”

Downstream ZAB-90/80 initiates the hand-off to ZAB-46. The AAL1063 flight crew checks in, self-reporting the active IM operation to ZAB-46.

The ZAB-46 controller monitors the speed of AAL1063 and spacing with UAL2031 and other aircraft in the sector until such time as they decide to cancel the operation or AAL1063 reaches BRDEY.

4.3.8 Cancellation Pair 2

When UAL2031 reaches the BRDEY, the ZAB-46 controller cancels the IM clearance and the AAL1063 flight crew will fly published speeds and altitudes for the PINNG arrival.

ZAB ATC: “American ten sixty-three, resume published speeds, contact Phoenix approach one two four point one”

AAL903: “American ten sixty-three, resume published speeds, contact Phoenix approach one two four point one”

The ZAB-46 controller removes all IM indications in the data blocks of both AAL1063 and UAL2031. The AAL1063 flight crew cancels the IM operation in the MCDU.

4.4 Scenario # 4: EAGUL Arrivals to KPHX

Scenario #4 describes the application of IM to aircraft arriving via the EAGUL6 STAR to KPHX. ZAB-93 will initiate IM as desired using time-based ASGs from TBFM for the MF (HOMRR). ZAB-39 may amend or cancel the IM if the ASG retrieved from the SWIM Tool is different at HOMRR. Figure 4-9 illustrates the aircraft, routes, IM special points, and ZAB sectors involved in the scenario.

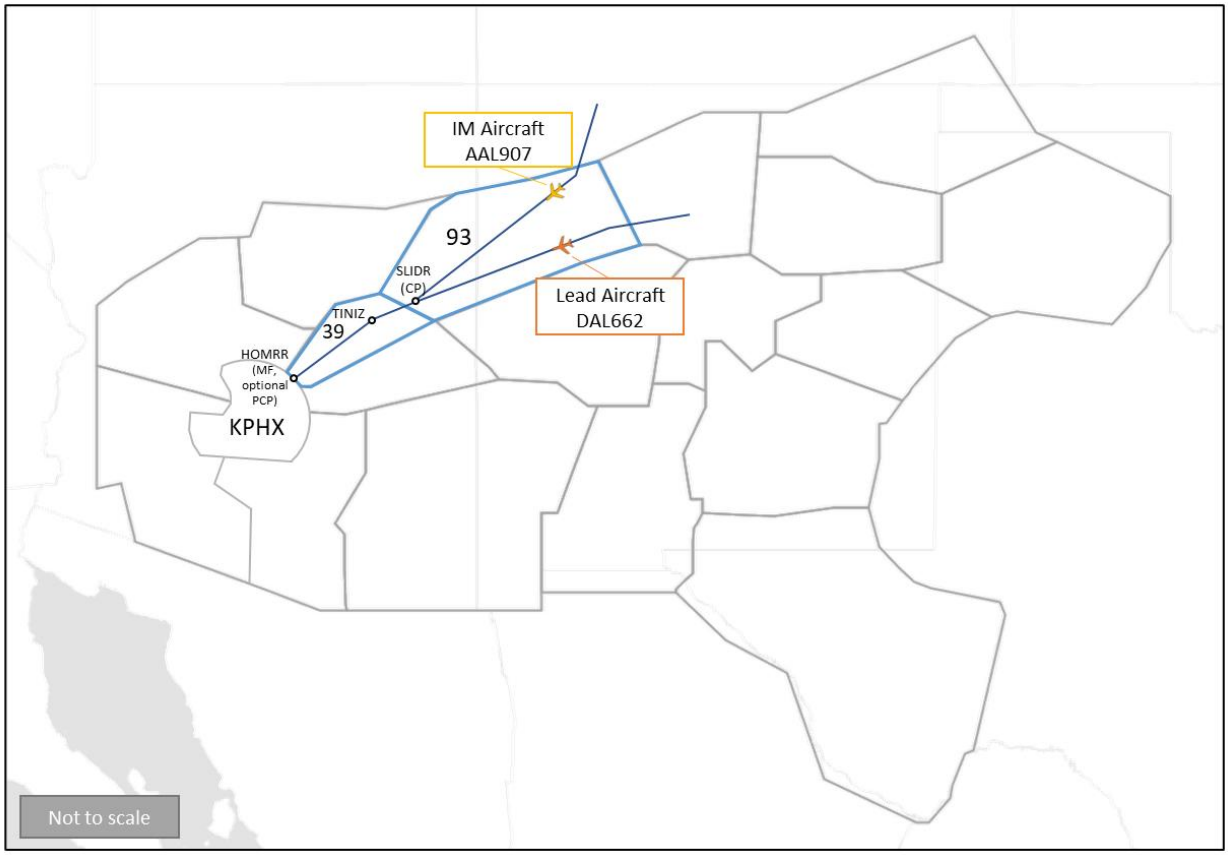

Figure 4-9. Scenario #4 – EAGUL Arrivals to KPHX

Table 4-7 summarizes the responsibilities of each ZAB sector expected to participate in this scenario.

Table 4-7. Scenario #4 Sector Responsibilities

Sector	Responsibilities
ZAB-93	➢ Assess traffic and, if appropriate, initiate IM for aircraft on the EAGUL6 arrival ➢ Monitor spacing and separation prior to handoff to ZAB-39 ➢ Cancel IM early if necessary
ZAB-39	➢ Accept IM pair from ZAB-93 ➢ Amend or cancel active IM operations that have changed ➢ Monitor spacing and separation

Sector	Responsibilities
	➢ Cancel IM early if necessary ➢ Ensure the IM clearance is appropriately canceled, and the IM Aircraft is provided the proper speed instruction for the descent to KPHX *Note: ZAB-39 and ZAB-38 are often run as a combined sector; ZAB-39 is used in the scenario to represent either standalone ZAB-39 or the combined sector.*

Table 4-8 lists the key parameters for the IM operation illustrated in this scenario.

Table 4-8. Scenario #4 Key IM Parameters

Parameter	Scenario Details	Notes
ASG	80 seconds	The ASG will be sourced from TBFM via the SWIM Tool based on the scheduled arrival times at the MF depicted in Figure 4-9. The scenario ASGs are used for illustrative purposes only and may not reflect actual spacing goals based on the differences in TBFM STAs.
IM Special Points	CP: Zuni (ZUN) or Slider (SLIDR) Optional PCP: Tiniz (TINIZ) or Homer (HOMRR)	Direct SLIDR is commonly used and is depicted in this scenario. The PCP is not used in this scenario.
Aircraft	IM Aircraft: AAL907 Lead Aircraft: DAL662	AAL907 is a suitably equipped and identified A321 aircraft.

Controllers have several options controllers when using IM to support the metering operations into KPHX on the EAGUL arrival, not all of which are included in the scenario. These include the following:

- A Maintain clearance may be used if the aircraft are already on the same route; a Cross clearance may be used after both aircraft are direct to SLIDR or ZUN (the Cross clearance is illustrated in Scenario #4).

- ZUN and SLIDR are merge points in ZAB-93 on the EAGUL arrival and are, therefore, suitable CPs for IM Cross clearances (SLIDR is used in Scenario #4).
- HOMRR may be used as a PCP as the last waypoint on the EAGUL arrival prior to the KPHX TRACON. TINIZ is the first waypoint on the STAR with a speed and altitude constraint and may be used as a PCP for IM. However, SLIDR may also be used as the PCP if it is desired to contain the operation to ZAB-93. A PCP is not used as part of the IM clearance in scenario #4, however the operation is canceled by the controller prior to hand-off of the Lead Aircraft to KPHX.

4.4.1 Pre-initiation

Aircraft landing at KPHX are established on published routes and are routinely required to be spaced by arrival sector controllers. Spacing requirements may be an MIT restriction or a time restriction. The spacing requirement is provided by the TMU and coordinated with affected sectors. In this scenario, ZAB-93 will deliver IM Aircraft over SLIDR a specified time behind the Lead Aircraft based on the TBFM schedule; other aircraft will be delivered over SLIDR with 8 NM separation. During the AIRS Evaluation and under current conditions, IM is established as a suitable technique for controllers to achieve the required spacing. In this scenario, metering is in effect and the ZAB controllers understand that time-based ASGs may be used to meet relative spacing objectives for suitably equipped AAL aircraft arriving on the EAGUL6 arrival into KPHX.

In this scenario, expecting to execute IM operations on arrivals into KPHX, the area supervisor will open an instance of the SWIM Tool for the Meter Fix (HOMRR) to provide pairs and ASGs based on the TBFM schedule. The time-based ASG is presented for all relevant pairs.

The ZAB-93 controller recognizes that a KPHX bound AAL A321 (AAL907) is a candidate to use IM to achieve the desired spacing by SLIDR. The ZAB-93 controller checks with the area supervisor to confirm the appropriate Lead Aircraft in the sequence to KPHX and to retrieve the time-based ASG from the SWIM Tool. The ZAB-93 controller identifies the appropriate Lead Aircraft in the sequence and ensures both aircraft are direct to SLIDR and then on the EAGUL6 arrival into KPHX. The controller defines the following IM clearance elements.

- Trail Aircraft = AAL907
- Lead Aircraft = DAL662
- ASG = 80 seconds
- Clearance Type = Cross
- CP = SLIDR

The ZAB-93 controller refers to an IM quick reference card to ensure that all applicable initiation criteria are satisfied prior to initiating the IM operation.

4.4.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied the controller transmits the clearance to the AAL aircraft.

ZAB ATC: "American nine zero seven cross SLIDR eight zero seconds behind Delta six sixty-two"

AAL907: "American nine zero seven roger cross SLIDR eight zero seconds behind Delta six sixty-two"

The ZAB-93 controller records that AAL907 is an active Trail Aircraft in the fourth line of AAL907's data block along with the 80 seconds ASG. The controller records that DAL662 is the Lead Aircraft in the fourth line of DAL662's data block.

The AAL907 flight crew assesses their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The AAL907 flight crew inputs the IM clearance parameters into the avionics, performs a cross-cockpit verification of the data entry, and confirms the acceptability of the IM operation.

4.4.3 Execution

The AAL907 flight crew flies the IM Command Speeds.

The ZAB-93 controller monitors the speed of AAL90 and spacing with DAL662 and other aircraft in the sector. The ZAB-93 controller may adjust the speed or vector the following aircraft to accomplish the required spacing behind AAL907.

The AAL907 flight crew continues to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitors for other IM-related notifications.

As AAL907 progresses, ZAB-93 initiates the hand-off to ZAB-39. The AAL907 flight crew checks in on the next frequency and self-reports that they are providing spacing behind lead aircraft DAL662.

AAL907: "Albuquerque Center, American nine zero seven, flight level two nine zero spacing behind Delta six sixty-two"

ZAB ATC: "American nine zero seven roger"

The ZAB-39 controller recognizes AAL907 as an IM Aircraft from the check-in and by observing "T80" in the fourth line of the data block.

The ZAB-39 controller monitors the speed of AAL907 and spacing with DAL662 and other aircraft in the sector. Prior to TINIZ, the ZAB-39 controller issues a descend via clearance for the EAGUL with the exception to maintain IM spacing. The AAL907 flight crew will comply with the IM Speeds and the published altitudes.

ZAB ATC: "American nine zero seven, descend via the EAGUL six arrival, runway two six transition, except maintain spacing"

AAL1063: "American nine zero, descend via the EAGUL six arrival, runway two six transition, except maintain spacing"

4.4.4 Cancellation

As the Lead Aircraft (DAL662) reaches the KPHX TRACON boundary and prior to hand-off, ZAB-39 controller cancels the IM clearance and the AAL907 flight crew will fly published speeds and altitudes for the EAGUL arrival.

> **ZAB ATC:** "American nine zero seven, resume published speeds, contact Phoenix approach one two eight point six five"
>
> **AAL907:** "American nine zero seven, resume published speeds, contact Phoenix approach, one twenty-eight sixty-five"

The ZAB-39 controller removes all IM indications in the data blocks of the AAL907 and DAL662 aircraft. The AAL907 flight crew cancels the IM operation in the MCDU.

5 REFERENCE DOCUMENTS

[1] ACSS (2019). *SafeRoute+ Pilot's Guide, Document Number 8007175-100, Revision A.* Aviation Communication & Surveillance Systems, LLC.

[2] FAA (2021). *ADS-B In Retrofit Spacing (AIRS) ADS-B In Capability Indicator Workaround Using the A321 Type Designator*. Rev 2.0.

[3] FAA (2021). Order JO 7110.65 *Air Traffic Control*.

[4] RTCA (2020a). *Safety, performance, and interoperability requirements document for Airborne Spacing – Flight Deck Interval Management (ASPA-FIM) (DO-328B)*. Washington, DC: RTCA.

Appendix A. Glossary

ADS-B Range	The range at which an aircraft can receive consistent ADS-B messages from an aircraft (e.g., Lead Aircraft). While the maximum range of ADS-B signals are 150 – 200 NM, environmental factors and traffic density may lower the effective range.
Assigned Spacing Goal (ASG)	The interval between the IM Aircraft and Lead Aircraft, assigned by the controller, in time or distance, as part of the IM Operation. The ASG is issued by the controller delivering the IM Clearance and is developed to achieve the controller's goal of establishing an efficient flow while maintaining separation from all traffic.
Clearance Type	IM clearances may be one of two types for the AIRS Evaluation: Cross or Maintain. A Cross clearance type will be used when the IM Aircraft and Lead Aircraft are initially on different routes that will merge at a common point, known as the CP, and then follow a common route to the PCP. A Maintain clearance type will be used when both aircraft are already on a common route to the PCP.
Crossing Point (CP)	A point on the IM Aircraft's Intended Flight Path, defined by a specific two-dimensional location, by which the ASG is required to be met. The ASG is not required to be met prior to the Crossing Point.
I-IM Application	The software that provides a subset of the IM capabilities defined by processing information entered in flight crew interfaces or provided by interfaces with other avionics systems.
IM Aircraft	The aircraft that is instructed to perform the IM Operation, also known as ownship or Trail Aircraft. This is the second aircraft in a pair of aircraft performing an I-IM procedure.

IM Clearance	The authority given to the flight crew of the IM Aircraft to conduct the IM Operation. This authority is communicated from the controller to the flight crew via an instruction containing all the elements necessary to conduct the operation: Lead Aircraft identification, clearance type, CP if necessary, ASG, and PCP if necessary.
IM Speed	The speed provided by the SafeRoute+ Equipment to achieve and / or maintain the Assigned Spacing Goal. Also referred to as the IM Command Speed.
Lead Aircraft	The aircraft against which the IM Aircraft is performing the IM Operation is the Lead Aircraft. A Lead Aircraft must be ADS-B Out equipped and transmitting ADS-B data. This is the first aircraft in a pair of aircraft performing an I-IM procedure.
Planned Cancellation Point (PCP)	A point on the IM Aircraft's Intended Flight Path where the IM Operation is terminated automatically.
SafeRoute+ Equipment	Includes the I-IM Application, the interfaces to the flight crew and to other avionics systems, and the automation needed to conduct the IM Operation.
Trail Aircraft	The second aircraft in an IM pair, spacing behind the Lead Aircraft. Also referred to as the IM Aircraft.

Appendix B. Acronyms

AAL	American Airlines
ACSS	Aviation Communication & Surveillance Systems
ADS-B	Automatic Dependent Surveillance – Broadcast
AGD	ADS-B Guidance Display
AIRS	ADS-B In Retrofit Spacing
ARTCC	Air Route Traffic Control Center
ASA	Airborne Surveillance Applications
ASG	Assigned Spacing Goal
ASPA-IM	Airborne Spacing – Interval Management
ATC	Air Traffic Control
CAS	CDTI-Assisted Separation
CAVS	CDTI-Assisted Visual Separation
CDTI	Cockpit Display of Traffic Information
CP	Crossing Point
CSMM	Call Sign Mismatch
DCT	Delay Countdown Timer
ERAM	En Route Automation Modernization
ESIS	Enhanced Status Information System
FAA	Federal Aviation Administration
FIM	Flight Deck-Based Interval Management
IFPI	Intended Flight Path Information
IFR	Instrument Flight Rules

I-IM	Initial-Interval Management
IM	Interval Management
IMC	Instrument Meteorological Conditions
KDFW	Dallas-Fort Worth International Airport
KPHX	Phoenix Sky Harbor International Airport
KSAN	San Diego International Airport
LOA	Letter of Agreement
MCDU	Multi-Purpose Control Display Unit
MIT	Miles-in-Trail
NAVAID	Navigation Aid
NextGen	Next Generation Air Transportation System
NM	Nautical Miles
P50	KPHX TRACON
PCP	Planned Cancellation Point
RNAV	Area Navigation
RTCA	Radio Technical Commission for Aeronautics
SOP	Standard Operating Procedures
STA	Scheduled Time of Arrival
STAR	Standard Terminal Arrival Route
STMC	Supervising Traffic Management Coordinator
SWIM	System Wide Information Management
TBFM	Time-Based Flow Management
TCAS	Traffic Collision Avoidance System
TMC	Traffic Management Coordinator
TMI	Traffic Management Initiative
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
VMC	Visual Meteorological Conditions
XMP	Extended Meter Points
ZAB	Albuquerque ARTCC
ZFW	Dallas-Fort Worth ARTCC
ZLA	Los Angeles ARTCC

Appendix C. Example of an ASG Lookup Table

Spacing in NM	Groundspeed at PCP in kts				
	280-300	310-330	340-360	370-390	400-420
6	75	70	65	60	55
7	90	80	75	65	60
8	100	90	85	75	70
9	110	100	95	85	80
10	125	115	105	95	90
11	140	125	115	105	95
12	150	135	125	115	105
	ASG in seconds				