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Preliminary Integration Study on Incorporating Air Traffic Control Procedures in the Integrated Domain Assessment Model

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Final Report

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16. Abstract <p>The FAA Air Traffic Safety Oversight Service (AOV) initiated a research project, the Integrated Domain Assessment (IDA), to support its approval, acceptance, and concurrence process for Safety Risk Management Document (SRMD) review. The initial IDA prototype developed as part of this research focused on SRMDs for new and modified National Airspace Systems (NASs) and is based on a model of the NAS architecture integrated with system safety hazard data. As part of future development, the IDA will be expanded to provide decision support to AOV in evaluating SRMDs for air traffic control (ATC) procedure changes related to separation minima. The technical implications of integrating ATC procedure SRMDs in the IDA must be examined to ensure that the IDA model and prototype design are adaptable for eventual inclusion of ATC procedure SRMDs.</p> <p>The purpose of this study is to understand the characteristics of ATC procedure changes and associated SRMDs, recommend IDA model updates, and identify further research needed to incorporate ATC procedure changes and related SRMDs. The feasibility of modeling interrelationships between ATC procedure changes and NAS systems is also explored. This study provides an overview of FAA Order 7110.65 and characterizes a sample of associated SRMDs for ATC procedure changes. Technical considerations for IDA model updates are explored, such as the types of hazards identified in procedure SRMDs; differences between procedure and system SRMDs; and potential interrelationships between procedure changes and systems.</p> <p>The recommendations from this study will be used to guide future research to extend the IDA concept of operations and data models to integrate ATC procedures and provide decision support for AOV's evaluation of both system- and procedure-related SRMDs.</p>			
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LIST OF ABBREVIATIONS AND ACRONYMS

A80	Atlanta Terminal Radar Approach Control
ConOps	Concept of Operations
AJV-8	FAA Mission Support Services Air Traffic Procedures Organization
AAC	Approval, Acceptance, and Concurrence
AOV	FAA Air Traffic Safety Oversight Service
ARTS	Automated Radar Terminal System
ASR	Airport surveillance radar
ATC	Air traffic control
ATCBI	Air Traffic Control Beacon Interrogator
ATL	Hartsfield-Jackson Atlanta International Airport
CERAP	Center Radar Approach Control
CFR	Code of Federal Regulations
ConOps	Concept of Operations
DARC	Direct Access Radar Channel
DCP	Document Change Proposal
FL	Flight level
FLM	Front-line manager
FMA	Final monitor aid
FSSS	Facility Specific Safety Standard
HCF	Honolulu Control Facility
HHR	Hawthorne Municipal Airport
IDA	Integrated Domain Assessment
LAX	Los Angeles International Airport
MBI	Mandatory briefing item
Micro-EARTS	Microprocessor En Route Automated Radar Tracking System
MSL	Mean sea level
NTZ	No-Transgression Zone
PBN	Performance-based navigation
PRM	Precision Runway Monitor
REW	Request Evaluation Worksheet
RNAV	Area Navigation
SDP	Service Delivery Point
SMS	Safety management system
SMTS	Safety Management Tracking System
SOP	Standard operating procedure
SRM	Safety Risk Management
SRMD	Safety Risk Management Document
SRMGSA	Safety Risk Management Guidance for System Acquisitions
SSOG	Single Source Area
STARS	Standard Terminal Automation Replacement System
WebCM	Web Configuration Management

EXECUTIVE SUMMARY

The FAA Air Traffic Safety Oversight Service (AOV) is responsible for independent safety oversight of air traffic services provided by the agency's Air Traffic Organization (ATO). In accordance with FAA Order 1100.161 Change 1, the AOV reviews ATO Safety Risk Management Documents (SRMDs) and approves, accepts, concurs with, or rejects:

- Controls that are proposed to mitigate high-risk safety hazards.
- Controls that cross multiple FAA lines of business (regardless of associated risk level).
- Changes or waivers to provisions of handbooks, orders, and documents, including FAA Order 7110.65, that pertain to separation minima.

One of the major challenges the AOV faces is that the ATO Safety Risk Management process focuses on individual changes to the National Airspace System (NAS), which means that an SRMD and associated risk controls do not necessarily consider potential interactions with other changes in the NAS. Focusing only on individual changes increases the possibility that hazards due to unanticipated consequences of interactions between changes may not be identified before implementation.

The primary mission of the Integrated Domain Assessment (IDA) is to assist the AOV with evaluating SRMD content in accordance with the AOV's Request Evaluation Worksheet (REW). The IDA guides users through a step-by-step process for analyzing SRMDs based on the REW criteria to highlight potentially overlooked hazards, missing causes, and control effectiveness issues.

The IDA's other mission is to identify potential safety impacts of proposed changes to the NAS. The intended use of the IDA is as a decision-support tool for the AOV's Approval, Acceptance, and Concurrence (AAC) process and Safety Management Action Review Team activities (i.e., the IDA is intended to be used in concert with AOV subject matter expertise and not as the sole basis for risk control or procedure approval decisions).

The IDA model serves as the foundation of the IDA tool, enabling functions to evaluate NAS change impacts, SRMD issues, and risk-control effectiveness. The model includes a repository of SRMD data and NAS systems linked to hazards and corresponding causes and controls in a structure that can be analyzed. System and hazard interrelationships are captured in the model and permit the IDA to identify dependencies between systems, hazards, and risk controls given proposed and implemented NAS changes. The IDA taxonomy, a fundamental component of the model for SRMD evaluation, is used to classify NAS changes, systems, and hazard analysis data by common types.

As part of future development, the IDA will be expanded to provide decision support to the AOV in evaluating SRMDs for air traffic control (ATC) procedure changes related to separation minima. The purpose of this study is to recommend IDA model updates and identify technical considerations for integrating ATC procedure changes and related SRMDs in the IDA framework. The recommendations from this study will be used to guide future research to extend the IDA

model to ATC procedures and provide decision support for the AOV's evaluation of both system- and procedure-related SRMDs.

This study presents an overview of FAA Order 7110.65, "Air Traffic Control," and a sample of SRMDs for proposed changes associated with Sections 5-5-4, "Minima," and 5-9-7, "Simultaneous Independent Approaches—Dual & Triple," within the Order. Key characteristics of the Order and procedure SRMDs are reviewed to identify procedure data that may be modeled in the IDA to evaluate ATC procedure changes. Related SRMDs are also surveyed to examine the types of procedure changes and hazards analysis data that may need to be integrated in the IDA model. As part of this survey, the IDA taxonomy is re-examined to determine the feasibility of addressing not only equipment but also procedure-related NAS changes and SRMDs.

The evaluation of procedure-related SRMDs shares the same principle as the evaluation of equipment-related SRMDs. Understanding and modeling procedure/system interdependencies and correlations among ATC procedures will enable the IDA to provide decision support for the AOV's evaluation of procedure and joint system/procedure SRMDs.

Procedure change-related SRMDs are evaluated by the AOV through either the AAC or a Facility Specific Safety Standard (FSSS) process based on the scope of the changes. Because both AAC and FSSS processes share the same SRMD evaluation criteria, the procedure SRMD evaluation support IDA provides can be applied to both processes.

The outcome of this study is an initial concept for modeling ATC procedures, procedure/system interrelationships, and related SRMDs in the IDA. Technical considerations for IDA model updates are explored, such as the types of hazards identified in procedure SRMDs; differences between procedure and system SRMDs; and how procedure changes are introduced in FAA Order 7110.65.

The recommendations from this study will be used to guide future research to update the IDA concept of operations and the data model to integrate ATC procedures and provide decision support for the AOV's evaluation of both system- and procedure-related SRMDs.

1. INTRODUCTION

1.1 BACKGROUND

The purpose of the Integrated Domain Assessment (IDA) research effort is to develop a decision-support tool to assist the FAA Air Traffic Safety Oversight Service (AOV) in evaluating safety hazard analyses for new and modified air traffic control (ATC) system equipment and ATC procedures and identifying potential safety impacts as a result of multiple National Airspace System (NAS) changes. The AOV reviews Safety Risk Management Documents (SRMDs) for proposed changes to the NAS to evaluate the adequacy of safety hazard analyses and associated risk controls. With IDA support, the AOV can more efficiently and effectively analyze SRMDs and NAS change impacts to identify safety issues that need more oversight attention. An initial IDA prototype completed in FY15 identifies interdependencies among NAS systems and system safety hazards and will be extended to model separation minima-related ATC procedures as part of future development. An overview of the IDA system concept and model is provided in section 2.

1.2 PURPOSE

The purpose of this study is to recommend IDA model updates and identify technical planning considerations for incorporating ATC procedure changes and related SRMDs in the IDA framework. The recommendations from this study will be used to guide future research to extend the IDA model to address ATC procedures and provide decision support for the AOV's evaluation of both system- and procedure-related SRMDs.

1.3 DOCUMENT STRUCTURE

An overview of the IDA mission, concept, and model is provided in section 2. FAA Order 7110.65 is discussed in section 3. The Order's structure, ATC procedure topics, and key characteristics are summarized to provide context for IDA updates needed to address procedure changes. Section 4 describes a sample of SRMDs for changes to separation minima-related procedures in FAA Order 7110.65. The SRMD sample is characterized according to the types of procedure changes and hazards analysis data to identify considerations for modeling procedure-related SRMDs. Preliminary updates to the IDA model to integrate ATC procedures and SRMDs are presented in section 5. The characteristics of FAA Order 7110.65 and the sampled SRMDs are used to identify potential IDA data model changes to accommodate ATC procedures and related SRMDs. Section 6 summarizes technical considerations for extending the IDA concept and model updates to integrate ATC procedures, NAS architecture, and SRMD data to provide decision support for the AOV's evaluation of SRMDs.

2. IDA OVERVIEW

2.1 AOV NEEDS

The AOV is responsible for independent safety oversight of air traffic services provided by the agency's ATO. In accordance with FAA Order 1100.161 Change 1, the AOV reviews ATO SRMDs and approves, accepts, concurs with, or rejects:

- Controls that are proposed to mitigate high-risk safety hazards.
- Controls that cross multiple FAA lines of business (regardless of associated risk level).
- Changes or waivers to provisions of handbooks, orders, and documents, including FAA Order 7110.65, that pertain to separation minima [1].

The AOV's Approval, Acceptance, and Concurrence (AAC) Work Instructions define a step-by-step process for the AOV's review of NAS equipment and ATC procedure-related SRMDs. Because SRMDs for ATC procedure changes follow the same ATO Safety Management System (SMS) provisions for Safety Risk Management (SRM), the AOV uses the same criteria to evaluate SRMDs for national versus facility-specific changes. Table 1 summarizes the questions identified in the AOV's AAC Request Evaluation Worksheet (REW) for SRMD reviews [2].

Table 1. REW questions

No.	Evaluation Criteria
1	How do you rate the adequacy of the system description?
2	How do you rate the description and documentation of the proposed change?
3	How do you rate the composition of the Safety Risk Management Panel?
4	Ensure that all supplemental documents have been included and signed by the appropriate level of authority (i.e., letters of agreement, Notice to Airmen, etc.).
5	For all requests that require coordination with AVS, the request lead must ensure that coordination has been achieved prior to rendering AOV's final disposition (e.g., AVS, Aircraft Certification Service, and Accident Investigation and Prevention).
6	How do you rate the identified hazards? Pay particular attention to single point of failure hazard(s).
7	How do you rate the evidence provided to support the determination of the worst credible outcome of an event (severity)? Pay particular attention to single point of failure hazard(s).
8	How do you rate the quantitative and/or qualitative evidence provided to support the determination of likelihood of an event? Pay particular attention to relevant existing control(s) and mitigation(s).
9	How do you rate the predicted initial and residual safety risk in terms of the adverse impact of the potential hazard(s)? Pay particular attention to single point of failure hazard(s).
10	How do you rate the adequacy of the proposed mitigation(s) to eliminate or control the adverse impact of the hazard(s)?
11	For changes to an existing SRMD, ensure that the ATO has provided objective evidence to validate that the previously approved mitigations(s) were implemented and objective evidence is provided to support the effectiveness of the mitigation.
12	How do you rate the adequacy of the continuous monitoring plan and the hazard tracking method?

AVS = Aviation Safety

To adequately answer the questions outlined in table 1, the AOV needs a support tool that is capable of identifying potential missing hazards, the effectiveness of proposed controls, and the safety impact of proposed changes in the context of multiple changes to the NAS. NAS system- or equipment-related SRMDs are evaluated by the AOV through its AAC process. Based on the scope of the changes, the AOV's AAC or Facility Specific Safety Standard (FSSS) process is used to evaluate ATC procedure-related SRMDs. Because both AAC and FSSS processes share the same SRMD evaluation criteria, the IDA modeling concepts for the procedure SRMD evaluation support discussed in this report are applied to both processes.

2.2 IDA CONCEPT

The IDA's primary mission is to assist the AOV with evaluating SRMD content in accordance with the AOV's REW. The IDA guides users through a step-by-step process for analyzing SRMD content based on the REW criteria summarized in table 1. The IDA's other mission is to identify potential safety impacts of proposed changes to the NAS. The intended use of the IDA is as a decision support tool for AOV safety oversight activities (i.e., the IDA is not intended to be used as the sole basis for an AAC decision, but rather as an aid for identifying potential SRMD issues).

One of the major challenges the AOV faces is that the ATO SRM process focuses on individual changes to the NAS, which means that an SRMD and associated risk controls do not necessarily consider potential interactions with other changes to the NAS. Focusing only on individual change increases the possibility that hazards, due to unanticipated consequences of interactions between changes, may not be identified before implementation. This situation applies to both equipment- and procedure-related SRMDs.

The IDA enables AOV users to more effectively and efficiently evaluate SRMDs and NAS change impacts by integrating multiple sources of system, safety, and NAS change data into a single platform. As part of future R&D, the IDA concept will also manage ATC procedure data and support the evaluation of ATC procedure-related SRMDs. The "Preliminary IDA Methodology Report" provides an overview of the IDA concept, which includes the following key functions [3]:

- Evaluate SRMD Content—Identify SRMD issues, such as potentially missing hazards and hazard causes, control vulnerabilities, and hazard-monitoring-plan deficiencies.
- Evaluate Effectiveness of Controls—Assist the AOV with determining whether proposed controls can be expected to reduce the risk, as indicated in the SRMD.
- Analyze System Impacts—Analyze the interdependencies among NAS systems, ATC procedures, and hazards to identify other systems, procedures, hazard causes, and risk controls that may be affected by changes to the NAS.
- Track SRMD and NAS Data—Maintain NAS system, ATC procedure, and SRMD data and provide utilities so the AOV can manage remarks and notifications concerning related safety oversight concerns.

Figure 1 shows that the IDA model constitutes the foundation of the IDA tool, enabling functions to evaluate NAS change impacts, SRMD issues, and risk-control effectiveness. The model includes a repository of SRMD data and NAS systems linked to hazards and corresponding causes and controls in a structure that can be analyzed. System and hazard interrelationships are captured in the model and permit the IDA to identify dependencies between systems, hazards, and risk controls given proposed and implemented NAS changes.

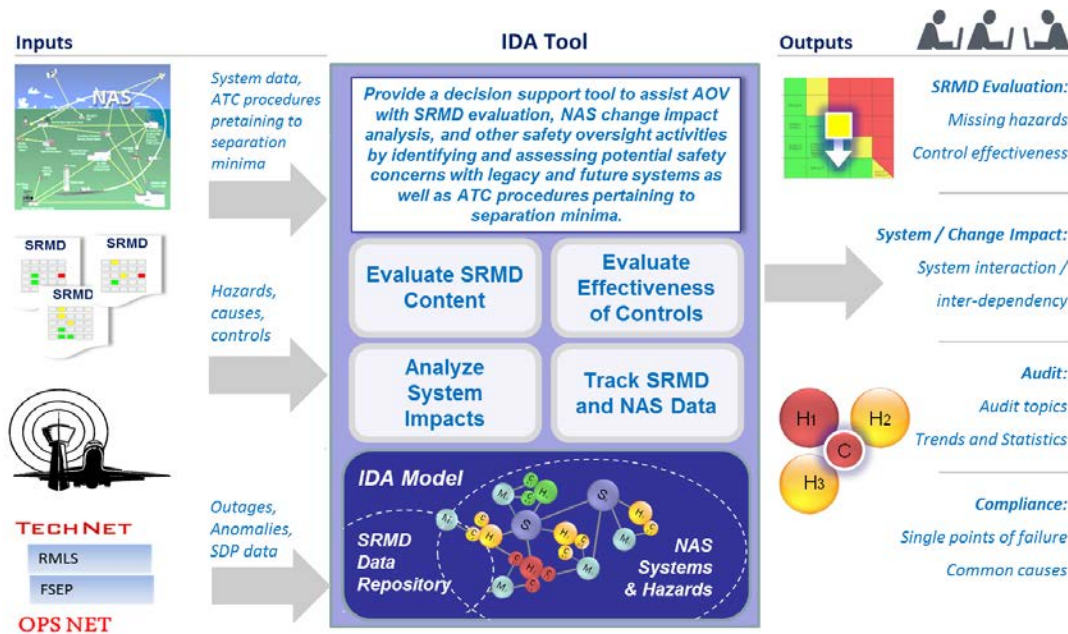


Figure 1. The IDA concept

To establish and maintain this model, the IDA integrates NAS architecture, system safety hazard, and NAS change data in a single database platform. As the NAS evolves, system architecture changes and supporting SRMDs are used to update the IDA model. As part of future development, the IDA model (see figure 1) will be extended to integrate ATC procedure data and related SRMDs.

The FY15 IDA prototype uses three types of data as inputs. System architecture data are obtained from the NAS Enterprise Architecture Systems Engineering Portal and system maintenance handbooks and Web Configuration Management (WebCM). Architecture data are used to set up systems in the IDA and track changes to systems and system interfaces over time. The SRMD data are obtained from AOV Connect, the ATO's Safety Management Tracking System; WebCM; and NAS Digital Libraries. The IDA processes hazard, cause, risk control, and other SRMD-related data to highlight potential safety issues such as potentially overlooked hazards, according to the AOV's REW. System performance data, which are used to calculate system performance indicator scores, are obtained from the FAA's TechNet and Operations Network Web sites.

2.3 IDA TAXONOMY

The IDA concept includes a taxonomy to classify NAS systems, NAS changes, hazards, causes, and controls by common types, as shown in figure 2 [4]. Because different SRMDs may describe similar hazard information using different terminology, a common taxonomy is needed to cross-reference and identify similar SRMDs, hazards, and other safety data to support the AOV's evaluation of SRMDs. The IDA's taxonomy is a key element of the model and methodology used to "flag" potential SRMD discrepancies for the AOV's review and to search for similar hazard data. Section 4.3 characterizes procedure SRMDs by change, hazard, cause, and control type to

examine the feasibility of applying the IDA’s existing taxonomy to procedure changes and related SRMDs.

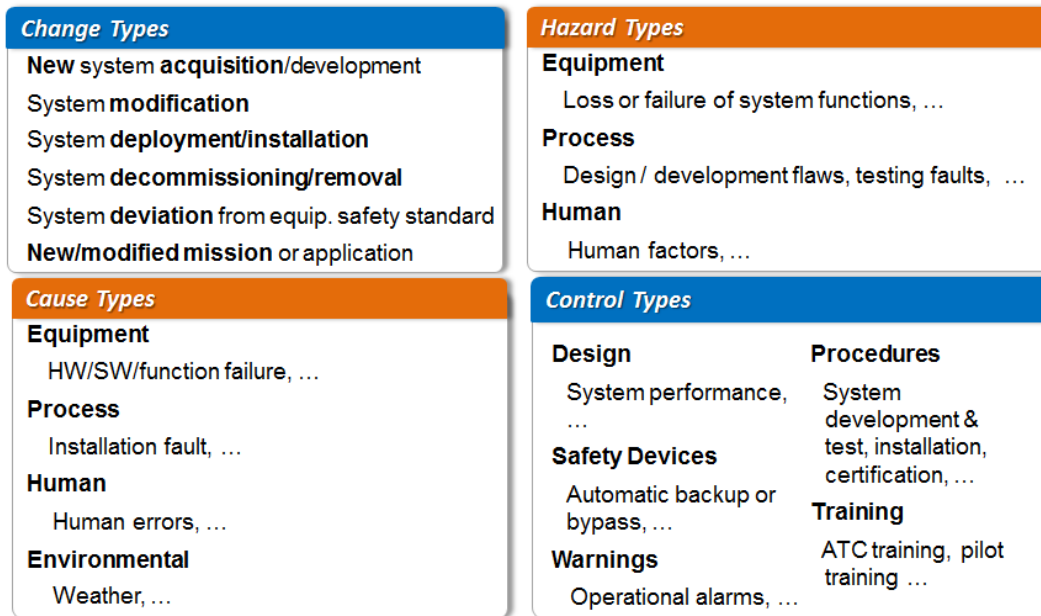


Figure 2. An IDA taxonomy excerpt

2.4 IDA INDICATORS

System performance and safety indicators are other fundamental components of the IDA concept. The IDA helps the AOV maintain situational awareness of NAS changes and analyze dependencies among multiple system changes to identify safety concerns in preparation for future SRMD reviews, potential audit topic identification, and other safety oversight activities. To do so, the IDA presents safety and system performance indicators based on system safety and NAS change impacts. These indicators, which are described in the previous “Preliminary IDA Methodology Report,” include [3]:

- **System Safety Influence**—Indicates how frequently a system is cited as a risk control or hazard cause.
- **System Impact**—Indicates the relative influence that a system may have on NAS operations and safety. Accounts for interrelationships among systems, hazards, and service delivery points. Includes System Safety Influence as a parameter.
- **NAS Change Impact**—Indicates the relative effect that a given change to a NAS system could potentially have on NAS safety, given change complexity, maturity, system interfaces, and safety influence. Includes System Safety Influence as a parameter.
- **Control Effectiveness**—The theoretical capability a set of controls has in achieving the risk level associated with a given hazard. Applies rules to assess the attributes of a set of controls in terms of suitability given hazard cause types; defenses in depth and breadth; and control autonomy from system faults and failures.

- System Instability—Indicates the number and types of changes that a system is expected to undergo and the timeframe in which the changes occur or are planned.
- System Unavailability—Indicates downtime of a given system across all ATC Service Delivery Points (SDPs).
- System Anomaly Rate—Indicates the frequency of corrective actions for a given system across all SDPs.

This study focuses on potential IDA model updates for integrating procedure SRMDs. A high-level assessment of adapting IDA's existing system indicators to procedure-related data is presented in section 5.2. However, specifications and methodologies for procedure indicators must be developed and validated as part of a future research task.

3. FAA ORDER 7110.65 ATC PROCEDURES

3.1 OVERVIEW

FAA Order 7110.65, "Air Traffic Control," prescribes ATC procedures and phraseology for use by personnel providing ATC services [5]. The primary objectives of ATC services are to prevent collisions between aircraft in the NAS and maintain a safe, orderly, and expeditious flow of traffic. Controllers are required to be familiar with the Order provisions applicable to their operational responsibilities and provide ATC services accordingly with certain exceptions. Deviations from the national Order apply when procedures or minima are prescribed in a letter of agreement, FAA directive, or military document; an emergency is declared and a deviation is necessary to assist affected aircraft; or as necessary to conform with International Civil Aviation Organization documents, National Rules of the Air, or special agreements for ATC service in non-U.S. airspace.

The ATC duty priorities are defined in FAA Order 7110.65, chapter 2. A controller's first priority is to separate aircraft and issue required safety alerts; ATC judgment must be used to prioritize all other provisions of the Order based on the operational situation. Other duty priorities are to support national security and defense activities, such as reporting unusual aircraft activities, and to provide additional services when higher-priority duties and other factors permit. Other factors include surveillance limitations, traffic load, communications frequency congestion, and ATC workload, among other considerations. These factors may be specified within the provisions of a specific procedure (e.g., a procedure that can be used only when the surveillance system is operational).

3.2 DESCRIPTION

FAA Order 7110.65 is organized into chapters and sections, as outlined in figure 3, with one or more paragraphs in each section that provides specific guidance/procedures/requirements.

Chapter 1 General	Chapter 5 Radar (continued)	Chapter 8 Offshore / Oceanic Procedures (continued)
1-1 Introduction	5-6 Vectoring	8-9 Pacific ICAO Region
1-2 Terms of Reference	5-7 Speed Adjustment	8-10 North American ICAO Region
Chapter 2 General Control	5-8 Radar Departures	Chapter 9 Special Flights
2-1 General	5-9 Radar Arrivals	9-1 General
2-2 Flight Plans	5-10 Radar Approaches – Terminal	9-2 Special Operations
2-3 Flight Progress Strips	5-11 Surveillance Approaches – Terminal	9-3 Special Use, ATC-assigned Airspace and Stationary ALTRVs
2-4 Radio and Interphone Communications	5-12 PAR Approaches – Terminal	9-4 Fuel Dumping
2-5 Route and NAVAID Description	5-13 Use of PAR for Approach Monitoring	9-5 Jettisoning of External Stores
2-6 Weather Information	5-14 Automation – En Route	9-6 Unmanned Free Balloons
2-7 Altimeter Settings	5-15 Common Automated Radar Terminal Systems (CATS) & Standard Terminal Automation Replacement System (STARS) – Terminal	9-7 Parachute Operations
2-8 Runway Visibility Reporting		9-8 UFO Reports
2-9 Automatic Terminal Information Service Procedures	Chapter 6 Non-radar	Chapter 10 Emergencies
2-10 Team Position Responsibilities	6-1 General	10-1 General
Chapter 3 Airport Traffic Control - Terminal	6-2 Initial Separation of Successive Departing Aircraft	10-2 Emergency Assistance
3-1 General	6-3 Initial Separation of Departing And Arriving Aircraft	10-3 Overdue Aircraft
3-2 Visual Signals	6-4 Longitudinal Separation	10-4 Control Actions
3-3 Airport Conditions	6-5 Lateral Separation	10-5 Miscellaneous Operations
3-4 Airport Lighting	6-6 Vertical Separation	10-6 Oceanic Emergency Procedures
3-5 Runway Selection	6-7 Timed Approaches	10-7 Ground Missile Emergencies
3-6 Airport Surface Detection Procedures	Chapter 7 Visual	Chapter 11 Traffic Management Procedures
3-7 Taxi and Ground Movement Procedures	7-1 General	Chapter 12 Canadian Airspace Procedures
3-8 Spacing and Sequencing	7-2 Visual separation	Chapter 13 Decision Support Tools
3-9 Departure Procedures and Separation	7-3 VFR-on-top	13-1 ERAM Decision Support Tools
3-10 Arrival Procedures and Separation	7-4 Approaches	13-2 Ocean21 – Oceanic
3-11 Helicopter Operations	7-5 Special VFR	Appendix A. Aircraft Information Fixed-Wing Aircraft
3-12 Sea Lane Operations	7-6 Basic Radar Service to VFR Aircraft – Terminal	Appendix B. Aircraft Information Helicopters/Rotorcrafts
Chapter 4 Instrument Flight Rules	7-7 Terminal Radar Service Area – Terminal	Appendix C. Aircraft Information Specific Amateur-Built/Experimental Aircraft
4-1 NAVAID use limitations	7-8 Class C Service Area – Terminal	Appendix D. Standard Operating Practice (SOP) for the Transfer of Position Responsibility
4-2 Clearances	7-9 Class B Service Area – Terminal	PILOT/CONTROLLER GLOSSARY
4-3 Departure Procedures	Chapter 8 Offshore / Oceanic Procedures	BRIEFING GUIDE
4-4 Route Assignment	8-1 General	
4-5 Altitude Assignment and Verification	8-2 Coordination	
4-6 Holding Aircraft	8-3 Longitudinal Separation	
4-7 Arrival Procedures	8-4 Lateral Separation	
4-8 Approach Clearance Procedures	8-5 Offshore/Oceanic Transition Procedures	
Chapter 5 Radar	8-6 Separation from Airspace Reservations	
5-1 General	8-7 North Atlantic ICAO Region	
5-2 Beacon systems	8-8 Caribbean ICAO Region	
5-3 Radar Identification		
5-4 Transfer Of Radar Identification		
5-5 Radar Separation		

Figure 3. The FAA Order 7110.65 Series W chapters and sections

Chapter 5 (“Radar”) contains the most procedures, followed by chapters 2, 3, 4, and 8, based on page count.¹

Chapter 2 (which specifies general control procedures) addresses flight-plan processing, radio communications, and weather advisories, among other procedures. Chapter 2 also outlines ATC positions and responsibilities for the en route sector, terminal radar/non-radar, and tower teams,

¹ FAA Order 7110.65 Series W has the following page counts (listed in parentheses) by chapter: Chapter 1 (12), Chapter 2 (68), Chapter 3 (64), Chapter 4 (48), Chapter 5 (80), Chapter 6 (24), Chapter 7 (26), Chapter 8 (32), Chapter 9 (26), Chapter 10 (24), Chapter 11 (2), Chapter 12 (2), and Chapter 13 (10).

noting that there are “no absolute divisions of responsibilities regarding position operations” within each team [5].

Chapter 3 provides procedures for airport traffic control, including runway selection; taxi and ground movement; and arrival and departure procedures and separation (the most extensive subsections within chapter 3), among others.

Chapter 4 addresses procedures that apply under Instrument Flight Rule, such as departure clearances; route and altitude assignment; and arrival and approach procedures.

Chapter 5 provides procedures that require ATC judgment to determine whether the radar presentation and equipment performance is adequate for radar services. Separation minima specified in chapter 5 are dependent on the type of surveillance system (and its performance) and airspace domain (i.e., terminal or en route), given traffic speeds and other characteristics.

Chapter 8, which specifies offshore and oceanic procedures, also addresses types of separation, including vertical, horizontal (longitudinal or lateral), composite vertical horizontal separation, and radar separation (where available).

Separation minima-related procedures are contained throughout multiple chapters in FAA Order 7110.65. A previous William J. Hughes Technical Center report, “A Study of Critical NAS Systems & Air Traffic Procedures Pertaining to Separation Minima,” examines criteria for identifying separation minima-related procedures for future IDA modeling [6]. The study maps FAA Order 7110.65 procedures by section to one or more traffic-control topics in the AOV’s Safety Oversight Circular, 09-11 “Safety Oversight Standards” [7], and the ATO’s Safety Guidance, 15-05 “Safety and Technical Training Guidance on Separation Minima,” which identifies the paragraphs that “contain measurable criteria in time and/or space that pertain to separation minima” [8]. This report identifies a set of procedures in FAA Order 7110.65, as shown in figure 4, that are directly associated with separation minima.

Chapter 2 General Control		Chapter 5 Radar (Continued)		Chapter 6 Non-Radar (Continued)	
2-1-1	ATC Service	5-5-1	Application	6-5-2	Minima on Diverging Radials
2-1-2	Duty Priority	5-5-2	Target Separation	6-5-3	DME Arc Minima
2-1-6	Safety Alert	5-5-4	Minima	6-5-4	Minima Along Other Than Established Airways or Routes
2-1-14	Coordinate Use of Airspace	5-5-5	Vertical Application	6-5-5	RNAV Minima - Diverging/Crossing Courses
2-1-19	Wake Turbulence	5-5-6	Exceptions	6-6-1	Application
2-1-21	Traffic Advisories	5-5-7	Passing or Diverging	6-6-2	Exceptions
2-1-28	RVSM Operations	5-5-8	Additional Separation for Formation Flights	6-7-5	Interval Minima
2-3-8	Aircraft Equipment Suffix	5-5-9	Separation from Obstructions		
Chapter 3 Airport Traffic Control - Terminal		5-5-10	Adjacent Airspace	Chapter 7 Visual	
3-7-2	Taxi and Ground Movement Operations	5-5-11	Edge of Scope	7-2-1	Visual Separation
3-8-3	Simultaneous Same Direction Operation	5-6-3	Vectors Below Minimum Altitude	7-4-2	Vectors for Visual Approach
3-8-4	Simultaneous Opposite Direction Operation	5-7-2	Methods	7-4-4	Approaches to Multiple Runways
3-9-4	Line Up and Wait	5-8-3	Successive or Simultaneous Departures	7-5-3	Separation
3-9-6	Same Runway Separation	5-8-4	Departure and Arrival	7-9-1	Application
3-9-7	Wake Turbulence Separation for Intersection Departures	5-8-5	Departures and Arrivals on Parallel or Nonintersecting Diverging Runways	7-9-4	Separation
3-9-8	Intersecting Runway/Intersecting Flight Path Operations	5-9-1	Vectors to Final Approach Course	Chapter 8 Offshore / Oceanic Procedures	
3-9-9	Nonintersecting Converging Runway Operations	5-9-6	Simultaneous Dependent Approaches	8-3-2	Separation Methods
3-10-3	Same Runway Separation	5-9-7	Simultaneous Independent Approaches - Dual & Triple	8-3-3	Mach Number Technique
3-10-4	Intersecting Runway/Intersecting Flight Path Separation.	5-9-8	Simultaneous Independent Close Parallel Approaches - Precision Runway Monitor (PRM) Approaches	8-4-2	Separation Methods
3-11-3	Helicopter Departure Separation	5-9-9*	Simultaneous Offset Instrument Approaches (SOIA) - High Update Radar	8-4-3	Reduction of Route Protected Airspace
3-11-4	Helicopter Arrival Separation	5-9-10*	Simultaneous Independent Approaches to Widely - Spaced Parallel Runways Without Final Monitors	8-4-4	Track Separation
3-11-5	Simultaneous Landings or Takeoffs			8-5-2	Course Divergence
3-12-2	Departure Separation			8-5-3	Opposite Direction
3-12-3	Arrival Separation			8-5-4	Same Direction
Chapter 4 Instrument Flight Rules		Chapter 6 Non-Radar		8-5-5	Radar Identification Application
4-5-1	Vertical Separation Minima	6-1-4	Adjacent Airport Operation	8-6-1	Temporary Stationary Airspace Reservations
Chapter 5 Radar		6-1-5	Arrival Minima	8-6-3	Temporary Moving Airspace Reservations
5-1-1	Presentation and Equipment Performance	6-2-1	Minima on Diverging Courses	8-7-3	Longitudinal Separation
5-1-2	Alignment Accuracy Check	6-2-2	Minima on Same Course	8-7-4	Lateral Separation
5-1-8	Merging Target Procedures	6-3-1	Separation Minima	8-8-3	Longitudinal Separation
5-3-1	Application	6-4-2	Minima on Same, Converging, or Crossing Courses	8-8-4	Lateral Separation
5-3-2	Primary Radar Identification Methods	6-4-3	Minima on Opposite Courses	8-9-3	Longitudinal Separation
		6-4-4	Separation By Pilots	8-9-4	Lateral Separation
				8-9-5	Composite Separation Minima
				8-10-3	Longitudinal Separation
				8-10-4	Lateral Separation
				Chapter 12 Canadian Airspace Procedures	
				12-1-4	Separation

Figure 4. Separation minima-related procedures in FAA Order 7110.65 Series W

FAA Order 7110.65 also includes a briefing guide that identifies procedure revisions since the last order publication. The briefing guide lists revised sections and provides line-by-line changes to procedure text. One or more changes may be associated with the same section (e.g., 5-5-4, “Minima”).

Table 2 shows that chapter 5 (“Radar”) has undergone the most changes—more than double the number of changes to any other chapter in just under four years. A total of 254 changes were made to FAA Order 7110.65, chapters 1–13, plus appendices.

Table 2. Procedure changes in FAA Order 7110.65 Series U, V, and W

Series	Change	Date	No. of Changes by Chapter														Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	Other	
W	Basic	12/10/15	2	9	9	5	37	3	9	1	-	2	1	-	16	-	94
V	Change 3	06/25/15	-	4	3	3	5	-	1	1	2	-	-	-	-	-	19
	Change 2	01/08/15	-	4	2	1	3	-	2	1	-	6	-	-	-	-	19
	Change 1	07/24/14	-	3	3	1	4	-	1	6	-	1	-	-	2	-	21
	Basic	04/03/14	1	4	1	13	13	3	5	-	-	-	-	-	-	-	40
U	Change 3	08/22/13	-	6	3	2	4	-	-	3	4	-	3	-	-	-	25
	Change 2	03/07/13	-	2	-	1	3	-	2	-	1	-	-	-	-	1	10
	Change 1	07/26/12	1	-	-	1	6	-	-	-	-	-	-	-	-	-	8
	Basic	02/09/12	-	2	6	8	1	-	-	-	1	-	-	-	-	-	18
		Total	4	34	27	35	76	6	20	12	8	9	4	0	18	1	254

3.3 CHARACTERISTICS

3.3.1 Procedure Relationships and Annotations

Procedures annotations, as explained by the terms of reference in FAA Order 7110.65, Chapter 1, can be used to identify procedure interrelationships with systems, air traffic domains, and other procedures. Procedures that are applicable to a specific facility type (e.g., en route, oceanic, or terminal) are denoted as such, and lack of a facility-type designation indicates that a procedure applies to all facility types. As shown in the FAA Order 7110.65 excerpts in appendix A, Section 5-5-4, “Minima,” identifies procedures applicable to terminal and en route domains. Notes, defined by FAA Order 7110.65 as “statements of fact, or of a prefatory or explanatory nature relating to directive material,” may cite other procedures and system equipment information [5].

In appendix A, notes in Section 5-5-4 cite other ATC procedures that should be used as a contingency or in certain circumstances in connection with the main procedure. References cite additional or supporting information sources, such as FAA and other agencies’ orders, directives, notices, Codes of Federal Regulations (CFRs), and Advisory Circulars. References throughout Section 5-5-4 identify other FAA Order 7110.65 sections relevant to a given procedure and provisions in FAA Order 7210.3, “FAA Facility Operation & Administration,” among other documents. Though the exact relationships among referenced procedures is not explicitly established in FAA Order 7110.65, references may still be useful when identifying what procedures are potentially impacted by another procedure change.

Annotations in FAA Order 7110.65 are also used to convey administrative and supplemental information that may need to be captured in the IDA. For example, procedure changes are annotated with a change number, an effective date, and change bars to denote substantive changes. Diagrams are provided throughout the Order to convey runway configurations, aircraft separation

distances, and flight courses, among other graphical information. Finally, the term “phraseology” is used to denote prescribed words and phrases to be used in ATC communications.

3.3.2 Publication Cycle and Versioning

According to FAA Order 7110.65 publication schedules, changes to the Order are usually effective every 168 days, and the overall “basic” series is updated approximately every 2 years. The Order is versioned by a letter suffix to denote the series, and a change number denotes interim updates between series. Interim updates are packaged in three numbered changes, each with a specified cutoff date for submission and an effective date of publication. The next series’ publication integrates and implements all prior approved changes except where otherwise noted. Series updates are planned approximately every 2 years. Publication schedule excerpts from FAA Order 7110.65 Series U, V, and W are shown in figure 5.

U			V			W		
Basic or Change	Cutoff Date for Submission	Effective Date of Publication	Basic or Change	Cutoff Date for Submission	Effective Date of Publication	Basic or Change	Cutoff Date for Submission	Effective Date of Publication
JO 7110.65U	8/25/11	2/9/12	JO 7110.65V	8/22/13	4/3/14	JO 7110.65W	6/25/15	12/10/15
Change 1	2/9/12	7/26/12	Change 1	4/3/14	7/24/14	Change 1	12/10/15	5/26/16
Change 2	7/26/12	3/7/13	Change 2	7/24/14	1/8/15	Change 2	5/26/16	11/10/16
Change 3	3/7/13	8/22/13	Change 3	1/8/15	6/25/15	Change 3	11/10/16	4/27/17

Figure 5. The FAA Order 7110.65 publication schedule

3.3.3 Change Management

The FAA’s Mission Support Services Air Traffic Procedures Organization (AJV-8) manages FAA Order 7110.65 and associated changes. Deviations or supplements to the national FAA Order 7110.65 may also be issued. If a proposed deviation or supplement affects the “level, quality, or degree of service needed,” the Mission Support Services’ Vice President must approve the change before implementation. Deviations and supplemental procedures may be captured in “local” ATC facility standard operating procedures (SOPs) and directives—entitled and structured in the same manner as the national FAA Order 7110.65.

According to Section 1-1-8 of FAA Order 7110.65, FAA personnel should submit proposed procedure changes to air traffic facility management. Recommended procedure changes from other sources should be submitted to the “appropriate FAA, military, or industry/user channels.” AJV-8 has established a correspondence mailbox to collect email submissions for proposed procedure changes, including the language to be used in FAA Order 7110.65. The Order notes that no changes will be published until system software has been updated to support the procedures.

A sample of interim change notices to FAA Order 7110.65 Series W is provided in table 3. These notices include procedure text changes not implemented in the Series W publication effective December 10, 2015. The effective and cancellation dates for individual change notices vary and are specified within the notice and on the FAA’s Order 7110.65 website.

Table 3. Notices related to FAA Order 7110.65

Number	Title	Effective	Cancellation
JO 7110.706	Approval of 3 NM Separation at or Below Flight Level 230 at Facilities Using En Route Automation Modernization	02/05/2016	11/10/2016
JO 7110.705	Pilot Report Information	03/01/2016	11/10/2016
JO 7110.704	Taxi and Ground Movement Operations	03/02/2016	11/10/2016
JO 7110.702	En Route Flight Advisory Service Realigned to Inflight Position	02/01/2016	11/10/2016
JO 7110.701	Cold Temperature Compensation	12/17/2015	05/26/2016
JO 7110.699	Acknowledgement of Automated Notifications	01/04/2016	05/26/2016
JO 7110.698	Time-Based Flow Management	12/10/2015	05/26/2016
JO 7110.696	Visual Separation	12/14/2015	05/26/2016

Note: Notices accessed on February 17, 2016 at the following URL:

https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.current/documentNumber/7110.65

4. ATC PROCEDURE SRMDS

The AOV is responsible for approving changes to FAA Order 7110.65 that pertain to separation minima per the AOV's Order 1100.161 Change 1. Accordingly, the IDA decision support for SRMD evaluation for NAS changes will need to be updated to address ATC procedure-related SRMDs and the system-related SRMDs already modeled in the IDA. As part of future R&D, the IDA will be updated to model, integrate, and analyze ATC procedure changes and SRMDs with NAS system data.

This study examines characteristics of ATC procedure-related SRMDs to identify any significant differences with the structure and basic content of system SRMDs already modeled in the IDA. The objective is to assess the feasibility of modifying and augmenting the IDA model to accommodate ATC procedure SRMDs.

The merits or adequacy of the hazard analyses in the sampled procedure SRMDs and the SRMD approval status are not germane to this feasibility assessment. The types of hazards, causes, and controls, and the interrelationships between procedures and systems, are the focus of this study.

Sections 5-5-4 and 5-9-7, "Minima" and "Simultaneous Independent Approaches–Dual & Triple," respectively, are from FAA Order 7110.65 and were selected for the analysis of related procedure

changes and SRMDs in this report because of their complexity and the variety of SRMDs associated with them.

4.1 OVERVIEW

The nine SRMDs outlined in table 4 were sampled to identify characteristics of procedure-related SRMDs. These SRMDs represent a mix of national and facility-specific changes to FAA Order 7110.65 Sections 5-5-4 (“Minima”) and 5-9-7 (“Simultaneous Independent Approaches–Dual & Triple”). FAA Order 711.65 excerpts, with the complete text of these sections, are provided in appendix A. They reflect the end result of all procedure changes approved with an effective date of December 10, 2015.

Details regarding procedure changes and hazard analyses for the first three SRMDs in table 4 are summarized in this section. Descriptions of the other six SRMDs have been omitted because they are similar to the types of NAS changes and hazard analyses represented in the first three SRMDs. For ease of reference, SRMDs are assigned a reference number and an abbreviated title in table 4.

Table 4. Procedure SRMDs

No.	Abbreviated Title	SRMD Title	Domains
1.	3 nmi En Route SRMD	Expansion of 3 NM Separation in the En Route Domain SRMD, Version 1.2, August 19, 2014 [9]	En Route
2.	Honolulu SRMD	Microprocessor En Route Automated Radar Tracking System Operational Use of Single Source Area for Sectors 9 and 10 at Honolulu Control Facility SRMD-HCFSSA-201J-1, Version 1.6, May 31, 2012 [10]	En Route, Terminal
3.	Atlanta SRMD	Simultaneous Triple Instrument Approaches for the Hartsfield-Jackson Atlanta International Airport SRMD, Version 3.0, January 5, 2012 [11]	Terminal
4.	ASR-11 3 nmi SRMD	Application of 3-NM Terminal Area Separation Standards for Air Surveillance Radar-11 SRMD, Version 1.0, September 1, 2011 [12]	Terminal
5.	Parallel Dependent & Simultaneous Independent Approaches SRMD	Parallel Dependent and Simultaneous Independent Approaches SRMD, SRMD-AJV-14-SIPIA/PD, DCP-SI-2010-001.1, January 2011 [13]	Terminal
6.	Simultaneous Independent Parallel Approaches SRMD	FAA JO 7110.65, Paragraphs 5-9-7 through 5-9-11 and FAA JO 7210.3, Paragraphs 10-4-6 through 10-4-8, Simultaneous Independent Parallel Instrument Approaches SRMD, Version 1.0, June 8, 2015 [14]	Terminal
7.	D10 Waiver SRMD	Dallas Fort Worth Terminal Radar Approach Control Waiver Request to the Transitional Requirements of FAA JO 7110.65 SRMD, SRMD-SCSAG0053358, Version 1.1, August 8, 2014 [15]	Terminal
8.	Atlanta EDO Waiver SRMD	Atlanta Terminal Radar Approach Control (A80) Atlanta Air Route Traffic Control Center Waiver FAAO JO 7110.65, Paragraph 5-5-4.b.4., MINIMA for Established on Departure Operations SRMD, Version 1.0, SRMD-A80-EDO-SI-2012-001, September 2012 [16]	Terminal, En Route
9.	LAX & HHR Waiver SRMD	LAX-HHR Instrument Approach Waiver Request SRMD, SRMD-HHR-LAX-2010-002, Version 1.8, May 2013 [17]	Terminal

ASR = Airport Surveillance Radar; DCP = Document Change Proposal; HHR = Hawthorne Municipal Airport; LAX = Los Angeles International Airport

4.2 DESCRIPTIONS

4.2.1 3 nmi En Route SRMD for Changes to Section 5-5-4

The 3 nmi En Route SRMD [9] proposes a change to FAA Order 7110.65 Series V, Section 5-5-4 c.3. An excerpt from Section 5-5-4 procedures in effect at the time is provided in figure 6; the text for which a change is proposed is highlighted. The change raises the altitude limit for 3 nmi separation from flight level (FL) 180 to FL 230. The Document Change Proposal (DCP) submitted for this change is reproduced in figure 7, which shows the original procedure side-by-side with the amended text. Because this is a DCP, the proposed change to Section 5-5-4 applies nationally; however, only those ATC facilities that provide en route separation services using Stage A/Direct Access Radar Channel (DARC) in terminal mosaic/multi-sensor mode are impacted.²

5-5-4. MINIMA

Separate aircraft by the following minima:

a. **TERMINAL.** Single Sensor ASR or Digital Terminal Automation System (DTAS):

NOTE-

Includes single sensor long range radar mode.

1. When less than 40 miles from the antenna- 3 miles.
2. When 40 miles or more from the antenna- 5 miles.
3. For single sensor ASR-9 with Mode S, when less than 60 miles from the antenna- 3 miles.
4. For single sensor ASR-11 MSSR Beacon, when less than 60 miles from the antenna- 3 miles.

NOTE-

Wake turbulence procedures specify increased separation minima required for certain classes of aircraft because of the possible effects of wake turbulence.

b. **TERMINAL. FUSION:**

1. Fusion target symbol - 3 miles.
2. When displaying ISR in the data block- 5 miles.
3. If TRK appears in the data block, handle in accordance with Paragraph 5-3-7, Identification Status, subparagraph b, and take appropriate steps to establish non-radar separation.

c. Stage A/DARC, Terminal Mosaic/Multi-Sensor Mode:

NOTE-

Mosaic/Multi-Sensor Mode combines radar input from 2 to 16 sites into a single picture utilizing a mosaic grid composed of radar sort boxes.

1. Below FL 600- 5 miles.
2. At or above FL 600- 10 miles.
3. For areas meeting all of the following conditions:
 - (a) Radar site adaptation is set to single sensor.
 - (b) Significant operational advantages can be obtained.
 - (c) Within 40 miles of the antenna.
 - (d) Below FL 180.
 - (e) Facility directives specifically define the area where the separation can be applied. Facility directives may specify 3 miles.

REFERENCE-

FAAO JO 7210.3, Para 8-2-1, Single Site Coverage Stage A Operations.

FAAO JO 7210.3, Para 11-8-13, Single Site Coverage ATIS Operations.

Figure 6. Original text from FAA Order 7110.65 Series V Section 5-5-4 c.3

² Subsequent DCPs modified the same subsection of 5-5-4. The reference to Stage A/DARC equipment was replaced with Enhanced Backup Surveillance System Terminal Mosaic/Multi-Sensor Mode in FAA Order 7110.65 Series W.

DOCUMENT CHANGE PROPOSAL/BRIEFING SHEET

FINAL DISPOSITION

ORDER/PUBLICATION: 7110.65V

CHANGE: 3

EFFECTIVE DATE: June 25, 2015

TRACKING #: 53- 5-5-4

SPECIALIST/ROUTING: Keith Chandler AJV-83 (202) 267-0558

1. PARAGRAPH NUMBER AND TITLE:

5-5-4. MINIMA

2. BACKGROUND: As a result of safety and analysis studies using analytical approximations, simulations, and flight tests comparing flight characteristics of targets between 13,000 ft. and FL180 to targets between FL180 and FL230, it was determined that the increased probability of the loss of separation between FL180 and FL230 was negligible as compared to similar events in the airspace below FL180.

3. EXPLANATION OF CHANGE: This change allows the expanded use of 3nm separation from below FL 180 up to and including FL230 when meeting the conditions specified in paragraph 5-5-4.

4. CHANGE:

OLD

5-5-4 MINIMA

Title thru c.3.(c).

(d) Below FL 180

Add

NEW

5-5-4 MINIMA

No Change

(d) Up to and including FL 230

NOTE-

The provisions of this rule do not apply above FL 230.

Figure 7. The DCP for procedure changes, per the 3 nmi En Route SRMD

It should be noted that other changes impacting Section 5-5-4, “Minima,” were integrated together in the FAA Order 7110.65 Series W publication effective December 10, 2015 and the final, updated procedure text differs from that in the DCP and SRMD (see appendix A). It can be inferred that separate SRMDs are prepared for one or more procedure changes but not necessarily all changes collectively impacting the same procedure.

The hazard analysis presented in the 3 nmi En Route SRMD [9] was prepared in accordance with the ATO SMS Manual version 2.1. One low-risk hazard (i.e., hazard 1) was identified, as shown in the SRMD excerpt reproduced in figure 8. Hazard 1, as described in the SRMD, is actually a restatement of the proposed NAS change (i.e., “Applying 3 nm separation from FL 180 to FL 230 [Reduced separation with higher airspeed]”).

Hazard Number (1)	Hazard Description (2)	Cause (3)	System State (4)	Existing Control or Requirement (5)	Possible Effect (6)	Severity/Rationale (7)	Likelihood/Rationale (8)	Current/Initial Risk (9)	Recommended Safety Requirements (10)	Predicted Residual Risk (11)
I	Applying 3nm separation from FL180 to FL 230 (Reduced separation with higher airspeed)	Pilot deviation or controller error Less time to react	IFR FL180 – FL230 High density / volume traffic / workload In Class A Airspace a)parallel same direction b)parallel opposite direction c)crossing courses d)discontinuing vertical separation.	7110.65 7210.3 Automation Training (OJT, briefings) Terminal Radar with sweep rate of one sweep per 4.6 second preferred because it reduces the likelihood of collision by an order of magnitude, but ARSR with 12 seconds per sweep is still good.	Loss of separation for 3nm separation compared to 5nm separation.	Minor – 4 Loss of separation would trigger a Low RAE with 1.98nm of separation, while providing 5 nm separation the low RAE would be triggered at 3.3nm spacing	Remote – C SMEs say that today's likelihood is extremely remote. After the change the SMEs believe the likelihood may be slightly higher.	4C Low	Develop an En Route mandatory briefing item (MBI) for the application of 3nm separation between FL180 and FL230 which must be completed by all effected En Route operational personnel prior to using this procedure.	4C Low

Figure 8. Hazard analysis worksheet for 3 nmi En Route SRMD

The 3 nmi En Route SRMD [9] identifies human-factors-related causes and a mix of existing controls related to documentation, training, and equipment. Causes are attributed to pilot or ATC errors and lower reaction time. Existing controls identified in the SRMD refer to FAA Orders 7110.65 and 7210.3 but do not cite specific sections within those orders. Another existing control identifies on-the-job training and briefings in general. Terminal and long-range radar surveillance systems and their associated sweep rates are also expressed as existing controls.

The SRMD refers to a collision risk analysis prepared by the FAA Surveillance and Broadcast Services Program, which concluded that “the probability that a deviation leads to a collision was found comparable between FL 180 and FL 230 and had a value more remote than the target level of safety threshold of 1.5×10^{-9} for fatal accidents per flight hour.” [9] The SRMD notes that the safety panel “did not assess the merits of the collision risk analysis” and used operational experience to assess the risk for hazard 1 [9].

One safety requirement is recommended in the SRMD, though that requirement does not reduce the predicted residual risk from the initial risk assessment. The recommended requirement is to develop and implement a mandatory briefing item (MBI) to train controllers on the actual procedure change.

4.2.2 Honolulu SRMD for Changes to Sections 5-5-3 and 5-5-4

The Honolulu SRMD [10] proposes changes to FAA Order 7110.65, Sections 5-5-3 (“Target Resolution”) and 5-5-4 (“Minima”). Though not explicitly stated in the SRMD, it is assumed that, given the SRMD date, the proposed changes were for FAA Order 7110.65, Series U (effective date of February 9, 2012). The Honolulu SRMD proposes changes to the same procedures as the 3 nmi En Route SRMD, but is dated approximately two years earlier.

Excerpts from FAA Order 7110.65 Series U Section 5-5-4—in effect in 2012—are shown in figure 9; the highlighted text are procedures for which a change was proposed. Though the change discussed in the SRMD also addresses Section 5-5-3, that section is omitted here for brevity. The DCP for changes associated with Section 5-5-4 is reproduced in figure 10 and shows the original procedure side-by-side with the amended text. Because this is a DCP, the proposed change to Section 5-5-4 applies nationally; however, the DCP text explicitly authorizes only San Juan Center Radar Approach Control (CERAP) and Honolulu Control Facility (HCF) to use the modified procedure.

b. Stage A/DARC, **MEARTS Mosaic Mode**,
Terminal Mosaic/Multi-Sensor Mode:

NOTE-

Mosaic/Multi-Sensor Mode combines radar input from 2 to 16 sites into a single picture utilizing a mosaic grid composed of radar sort boxes.

1. Below FL 600– 5 miles.
2. At or above FL 600– 10 miles.
3. For areas meeting all of the following conditions:
 - (a) Radar site adaptation is set to single sensor.
 - (b) Significant operational advantages can be obtained.
 - (c) Within 40 miles of the antenna.
 - (d) Below FL 180.
 - (e) Facility directives specifically define the area where the separation can be applied. Facility directives may specify 3 miles.

REFERENCE-

FAAO JO 7210.3, Para 8-2-1, Single Site Coverage Stage A Operations.
FAAO JO 7210.3, Para 11-8-15, Single Site Coverage ATTS Operations.

4. When transitioning from terminal to en route control, 3 miles increasing to 5 miles or greater, provided:

- (a) The aircraft are on diverging routes/courses, and/or
- (b) The leading aircraft is and will remain faster than the following aircraft; and
- (c) Separation constantly increasing and the first center controller will establish 5 NM or other appropriate form of separation prior to the aircraft departing the first center sector; and
- (d) The procedure is covered by a letter of agreement between the facilities involved and limited to specified routes and/or sectors/positions.

c. MEARTS Mosaic Mode:

NOTE-

1. *Sensor Mode displays information from the radar input of a single site.*
2. *Procedures to convert MEARTS Mosaic Mode to MEARTS Sensor Mode at each PVD/MDM will be established by facility directive.*
 1. When less than 40 miles from the antenna– 3 miles.
 2. When 40 miles or more from the antenna– 5 miles.

Figure 9. Original text from FAA Order 7110.65 Series U Section 5-5-4

DOCUMENT CHANGE PROPOSAL/BRIEFING SHEET
FINAL DISPOSITION

ORDER/PUBLICATION: 7110.65U
CHANGE: 3
EFFECTIVE DATE: August 22, 2013 **TRACKING #:** 53- 5-5-4
SPECIALIST/ROUTING: Keith Chandler AJE-31 (202) 385-8442

1. PARAGRAPH NUMBER AND TITLE:

5-5-4. MINIMA

2. BACKGROUND: MEARTS Single Source Polygon was developed for MEARTS facilities to provide radar coverage in areas where the Single Sensor Mode radar had no coverage and single sensor radar was required. Single Sensor Polygon allows the controller to remain in Mosaic Mode and transition to 5 mile radar separation instead of nonradar separation when the single sensor is not receiving a target return. This is accomplished by using automation to display targets not eligible for three mile separation differently than targets that are eligible for three mile separation. This procedure became operational in the San Juan Combined Center/RAPCON (CERAP) on November 3, 2007 and no incidents have occurred and no new hazards have been identified.

3. EXPLANATION OF CHANGE: This change incorporates the requirements and separation standards used by San Juan CERAP in Waiver 07-E-20A into FAA JO 7110.65. This will allow San Juan CERAP and Honolulu Control Facility to use MEARTS Single Sensor Mode separation standards while operating in Mosaic Mode. Additionally, this change adds a new paragraph to address MEARTS Mosaic Mode Utilizing Single Source Polygon.

4. CHANGE:

<u>OLD</u>	<u>NEW</u>
Title thru a.3.	No Change
b. Stage A/DARC, MEARTS Mosaic Mode, Terminal Mosaic/Multi-Sensor Mode:	<u>b. Stage A/DARC, Terminal Mosaic/Multi-Sensor Mode:</u>
b. 1. thru b. 4	No Change
c. MEARTS Mosaic Mode:	No Change
<i><u>NOTE-</u></i>	
<i><u>1. Sensor Mode displays information from the radar input of a single site.</u></i>	Delete
<i><u>2. Procedures to convert MEARTS Mosaic Mode to MEARTS Sensor Mode at each PVD/MDM will be established by facility directive.</u></i>	Delete
<i><u>1. When less than 40 miles from the antenna – 3 miles.</u></i>	Delete
<i><u>2. When 40 miles or more from the antenna – 5 miles.</u></i>	Delete

Figure 10. The DCP for procedure changes, per the Honolulu SRMD

- Add 1. Below FL 600- 5 miles.
- Add 2. At or above FL 600- 10 miles.
- Add 3. For areas meeting all of the following conditions – 3 miles:
- Add (a) Radar site adaptation is set to single sensor mode.
- Add NOTE:
1. Single sensor Mode displays information from the radar input of a single site.
- Add 2. Procedures to convert MEARTS Mosaic Mode to MEARTS Single Sensor Mode at each PVD/MDM will be established by facility directive.
- Add (b) Significant operational advantages can be obtained.
- Add (c) Within 40 miles of the antenna.
- Add (d) Below FL 180.
- Add (e) Facility directives specifically define the area where the separation can be applied and define the requirements for displaying the area on the controller's PVD/MDM.
- Add 4. MEARTS Mosaic Mode Utilizing Single Source Polygon (San Juan CERAP and Honolulu Control Facility only) – 3 miles provided:
- Add (a) Less than 40 miles from the antenna below FL 180 and targets are from the adapted sensor.
- Add (b) The single source polygon must be displayed on the controller's PVD/MDM.
- Add (c) Significant operational advantages can be obtained.
- Add (d) Facility directives specifically define the single source polygon area where the separation can be applied and specify procedures to be used.
- Add (e) Controller must commence a transition to achieve either vertical separation or 3 mile lateral separation in the event that either target is not from the adapted sensor.
- No further changes to paragraph.
5. INDEX CHANGES:
6. REFERENCE CHANGES:
7. GRAPHICS:
8. GENOT/NOTICE:
9. FORMATTING & PLAIN LANGUAGE REVIEW: ☐
10. SAFETY RISK MANAGEMENT: (Check appropriate box).
☐ SRMD. Proposed change meets full SMS requirements for safety risk assessment.
☒ SRMDM. Proposed change does not introduce new safety risks into the NAS.
11. ICAO DIFFERENCES: YES ☐ NO ☐

Heather Hemdal
Director, En Route and Oceanic Safety
and Operations Support

Date:

Figure 10. The DCP for procedure changes, per the Honolulu SRMD (continued)

The HCF Microprocessor En Route Automated Radar Tracking System (Micro-EARTS) [10] uses a “single site” adaptation for the Maui radar for certain airspace sectors. This adaptation allows ATC to apply 3 nmi separation, per FAA Order 7110.65 Sections 5-5-3 and 5-5-4. With this single-

site adaptation, there is no overlapping radar coverage and total loss of radar coverage occurs when the radar is down. In this event, the controller must apply non-radar separation procedures (addressed in chapter 6 of FAA Order 7110.65). According to the SRMD, radar service cannot be reestablished until Micro-EARTS adjustments are made to allow a mosaic display using surrounding radar sites. Essentially, this SRMD combines a system change for automation with ATC procedure changes.

The change to the NAS described in the Honolulu SRMD proposes that certain HCF sectors be adapted with a Micro-EARTS Single Source Area (SSOG), which includes the airspace within 40 nmi of the Maui radar antenna below FL 180. The SSOG sectors use the Maui radar as the primary sensor, but other adjacent Air Traffic Control Beacon Interrogator (ATCBI) radars (ATCBI-5 and ATCBI-6) are used as mosaic backups. Micro-EARTS allows an area to be adapted for colored radar targets and data blocks to indicate radar sensor. Aircraft targets detected by Maui radar within the SSOG would be displayed in green, indicating eligibility for 3 nmi separation. If the Maui radar (the primary sensor) fails, the target changes color and is encircled, indicating that a sensor other than the Maui radar is used and 3 nmi separation can no longer be applied. Given the mosaic capability, radar contact is still maintained with the aircraft during the transition to increased separation standards (i.e., 5 nmi separation under certain conditions).

The Honolulu SRMD notes that the Micro-EARTS SSOG capability was developed nationally and became part of the system baseline with 5 years of operating history at the San Juan CERAP.

The hazard analysis presented in the Honolulu SRMD was prepared in accordance with ATO SMS Manual version 2.1. Two low-risk hazards were identified, and the hazard table provided in the SRMD is reproduced in figure 11. Hazard 1, which can be characterized as human factors, addresses the potential for the controller to be confused by the color-coded data blocks and targets displayed on Micro-EARTS. Hazard 2 addresses the potential for a Micro-EARTS software malfunction.

(1) Hazard #	(2) Hazard Description	(3) Causes	(4) System State	(5) Possible Effect	(6) Severity/ Rationale	(7) Existing Control or Requirement	(8) Likelihood/ Rationale	(9) Current / Initial Risk	(10) Recommended Safety Requirements	(11) Predicted Residual Risk
1	A controller misunderstands or is unaware of the functionality change	Inadequate controller training	Any ATC traffic level where a controller has SSOG enabled	Reduction in separation as defined by a low/moderate severity operational error	Major - Reduction in separation as defined by a low/moderate severity operational error	- Controller training/briefing - Visual indication of target color and indicator change. - AT procedures developed.	Extremely Remote - Unlikely but can reasonably be expected to occur in the system life cycle	Low Risk – 3D	All special provisions, conditions and limitations listed in Section 8 of this SRMD and the requested waiver	Low Risk – 3D
2	The software change could adversely affect another function of the program resulting in a coding conflict with existing code that could produce an unexpected outcome.	Coding oversight	Any ATC traffic level where a controller is using this change	Slight reduction in ATC capability, or significant increase in ATC workload	Minimal - Slight reduction in ATC capability, or significant increase in ATC workload	- S/W design, code & tests reviewed by independent analyst. - Change thoroughly tested. - Fallback procedure in place	Extremely Remote - Unlikely but can reasonably be expected to occur in the system life cycle	Low Risk – 5D	All special provisions, conditions and limitations listed in Section 8 of this SRMD and the requested waiver	Low Risk – 5D

Figure 11. Hazard analysis worksheet for the Honolulu SRMD

The Honolulu SRMD identifies causes and existing controls related to ATC training and a software coding process in addition to other types of causes and controls. Inadequate ATC training is the single cause identified for hazard 1, which entails a lack of ATC understanding of a functional change. A single cause is also identified for hazard 2 and is a software coding oversight. The existing controls for hazard 1 entail a mix of ATC training, equipment display design features, and a general reference to air traffic procedures. The existing controls for hazard 2 are process controls for software design, coding, and testing and a non-specific fallback procedure.

The same safety requirements are recommended for both hazards. The SRMD refers to “special provisions, conditions, and limitations”[10] documented in the SRMD and in an associated waiver. These terms, provided in figure 11, are the requisite air traffic separation standards to apply based on target color and symbols displayed on Micro-EARTS and initial and recurring ATC training. The SRMD also includes a statement that the provisions, conditions, and limitations of the requested waiver will be incorporated in local HCF Order 7110.XX, “Procedures for Use of the SSOG R9/10 for Kahului Airport Area.”

Note that the recommended safety requirements in figure 11 reference the following special provisions, conditions, and limitations:

Operations conducted under this waiver are subject to the following:

- a. This waiver is limited to aircraft operations in the HCF SSOG within 40 nautical miles (NM) of the Maui radar antenna below flight level 180.
- b. A minimum 3 NM separation standard must be applied between two targets within 40 NM from the Maui radar antenna and below FL180 in the HCF SSOG if the targets are:
 - 1) Two green beacon slashes.
 - 2) Two green primaries.
 - 3) One green beacon slash and one green primary.
- c. A minimum 5 NM separation standard must be applied between the following within 40 NM from the Maui radar antenna and below FL180 in the HCF SSOG:
 - 1) Two white beacon slashes with a white circle around them.
 - 2) Two white primaries with a white circle around them.
 - 3) A green beacon slash and a white beacon slash with a white circle around it.
 - 4) A green beacon slash and a white primary with a white circle around it.
 - 5) A green primary and a white beacon slash with a white circle around it.
 - 6) A green primary and a white primary with a white circle around it.
- d. When using the special procedures covered under this waiver, a video map must be displayed identifying the lateral limits of the Single Source capability.
- e. The provisions, conditions, and limitations of the requested waiver will be incorporated into HCF Order 7110.XX, Procedures for Use of the SSOG R9/10 for Kahului Airport Area.
- f. The facility training manager or front-line manager (FLM) must conduct face-to-face briefings with all HCF operational personnel prior to implementation.
- g. The controller work force must be trained on the proper use of the waiver annually. [10]

4.2.3 Atlanta SRMD for Changes to Section 5-9-7

The Atlanta SRMD [11] proposes changes to FAA Order 7110.65, Section 5-9-7 a.4(b). Though not explicitly stated in the SRMD, it is assumed that, given the SRMD date, the proposed changes were for FAA Order 7110.65, Series U (effective date of February 9, 2012). The version of FAA Order 7110.65 in effect during the time the Atlanta SRMD was prepared states that “triple parallel approaches to airports where the airport field elevation is 1000 feet mean sea level (MSL) or more require the high resolution color monitor with alert algorithms and an approved FAA aeronautical study,” per 5-9-7a4(b) [5]. Waiver 06-T-01C authorizes the Atlanta Terminal Radar Approach Control (A80) and Hartsfield-Jackson Atlanta International Airport (ATL) tower to conduct simultaneous instrument approaches to triple parallel runways without the use of such a monitor with alerts. Because A80’s Precision Runway Monitor (PRM)—a system that satisfies the requirement for a color monitor with alerts—may be out of service or unavailable, a waiver is needed to conduct triple-parallel approaches given that ATL’s field elevation exceeds 1000 feet MSL.

The Atlanta SRMD describes the current system under waiver 06-T-01, in which simultaneous dual approaches are used for two parallel runways separated by more than 4300 feet and simultaneous triple approaches are used for three parallel runways. The ATC uses the ASR-9 radar

and Common Automated Radar Terminal System (ARTS) Color Displays or (when available) the PRM to monitor the final approach courses. The proposed change per the Atlanta SRMD is the renewal of waiver 06-T-01. No deviations from, or changes to, FAA Order 7110.65 are proposed other than what was specified in the previously approved waiver.

Based on a waiver renewal checklist attachment to the Atlanta SRMD, it is assumed that the hazard analysis was prepared under ATO SMS Manual version 2.1. The Atlanta SRMD identifies two hazards for conducting triple approaches without the aid of a PRM system, as shown in figure 12. The first hazard (A80-001) addresses a scenario in which an aircraft blunders into a No-Transgression Zone (NTZ), an area between final approach courses in which flight is normally not allowed. A second low-risk hazard (A80-002) is described as “aircraft performance at field elevations at 1000 ft. MSL or greater.” Hazard A80-002 refers to an FAA Flight Standards collision risk simulation from 2002 used to support the risk assessment, given the “negligible impact” a field elevation difference of 26 feet would have on air traffic.

Hazard Number	Hazard Description	Cause	System State	Possible Effect	Existing Controls	Severity/ Rationale	Likelihood/ Rationale	Current Risk	Recommended Safety Requirements	Residual Risk
A80-001 Para 5-9-7a4(b)	Aircraft blunders into NTZ	a) Equipment malfunction b) Human error c) Weather	Simultaneous Triple Instrument approaches (IMC)	Loss of Separation	<ul style="list-style-type: none"> Radar monitoring Controller intervention Frequency override capability Aircraft equipment capabilities All special provisions conditions and limitations as listed in the existing waiver 	3/Major Based on Expert judgment Refer to risk summary	D/Extremely Remote/ Once every 10-100 years There have been no aircraft blunders in the last six years attributable to this waiver.	3D/Low Risk	Requirements in the existing waiver are sufficient	3D/Low
A80-002 Para 5-9-7(a)3	Aircraft performance at field elevations 1000' or greater	Airport elevation (1026')	Same as above	Negligible as per AFS-400 simulation studies.	None required	5/Minimal	E/Extremely Improbable	5E/Low	Requirements in the existing waiver are sufficient	5E/Low

Figure 12. Hazard analysis worksheet for Atlanta SRMD

The Atlanta SRMD’s Executive Summary notes key existing controls are “the use of Common ARTS conflict (CA), ASDE-X, redundant systems, radar monitoring, standard breakout procedures and controller training” [11]. The traceability between these existing controls and the hazard analysis worksheet (Appendix A of the Atlanta SRMD) is not always explicitly documented (i.e., specific equipment names, such as Airport Surface Detection Equipment–Model X [ASDE-X], are not mentioned).

Note that the existing controls and recommended safety requirements in figure 12 reference the following special provisions and limitations in the waiver associated with the Atlanta SRMD:

Operations conducted under this waiver are subject to the following:

- a. All provisions of FAA Order JO 7110.65, paragraph 5-9-7 (except the requirements of a3, airport field elevation less than 1000 feet MSL and a(4)(b) without the use of a high resolution color monitor with alert algorithms, such as the final monitor aid (FMA) or that required by the PRM program). A80 will use the ASR-9 radar system.
- b. Aircraft breakout procedures must be accomplished in accordance with the pullout procedures established in the A80 SOP 7110.65.
- c. The provisions of this waiver must be documented in and implemented through local facility directives.
- d. Facility directives must define the position responsible for providing the minimum applicable longitudinal separation between aircraft on the same final approach course.
- e. Controllers must receive initial training and annual refresher training on the application of the procedures pertaining to this waiver.
- f. ATO-T must be immediately advised of any temporary or permanent change that would affect the relative conditions of this waiver. [11]

4.3 CHARACTERISTICS

Characteristics of the nine SRMDs identified in table 4 are discussed in sections 4.3.1–4.3.8. The types of NAS changes associated with each SRMD are discussed along with the scope of the change (i.e., whether the scope is national or local). System interdependencies noted across most of the SRMDs are also addressed. Finally, SRMDs are examined in terms of hazard analysis worksheet data provided in appendix B, where hazards, causes, controls, and safety requirements are annotated according to the IDA taxonomy.

4.3.1 Procedure Change Topics and Domains

The sampled SRMDs indicate that one SRMD may address multiple procedure changes, and one procedure change may be linked to multiple SRMDs. In addition, the procedure changes proposed in an SRMD may affect multiple domains, such as terminal and en route.

Five of the sampled SRMDs involve national DCPs for one or more changes to FAA Order 7110.65, Sections 5-5-4 and 5-9-7. In three cases, the DCP extends terminal separation minima to additional airspace, in which procedure changes are predicated on surveillance and automation equipment capabilities. Namely, the 3 nmi En Route SRMD [9] requires En Route Automation Modernization, the Honolulu SRMD [10] requires Micro-EARTS, and the ASR-11 3 nmi SRMD [12] requires Standard Terminal Automation Replacement System (STARS) in addition to ASR-11. In the case of the Honolulu SRMD, a change is proposed to the national FAA Order 7110.65, but the text for the procedure change is restricted to two facilities (i.e., San Juan CERAP and HCF). The other two national DCP address changes are to instrument approach procedures for parallel runways (namely, the DCPs accompanying the Parallel Dependent & Simultaneous Independent Approaches SRMD [13] and the Simultaneous Independent Parallel Approaches SRMD [14]). The same SRMDs also bundle multiple DCPs together, including changes to other FAA Order 7110.65 Sections, FAA Order 7210.3, the Aeronautical Information Manual, and the

Aeronautical Information Publication. One SRMD, therefore, may be linked to many procedure changes.

Four SRMDs accompany waivers, including one waiver renewal in the case of the Atlanta SRMD. Two of the waivers also address changes to instrument approaches to parallel runways, and two address departure procedure modifications to use passing and diverging rules in the transition from terminal to en route airspace. It is noted that procedure deviations based on authorized waivers may be addressed in local facility directives and SOPs—artifacts that are not necessarily planned for inclusion in the IDA model given the volume of data that would entail. In addition, there are cases for which a waiver that is initially approved for one facility is proposed for additional facilities (e.g., the Atlanta SRMD was preceded by a waiver for the same procedure at San Juan CERAP). Therefore, one procedure change may be linked to multiple SRMDs when a facility-specific waiver is reused for additional facilities.

One aspect of waiver-related SRMDs that does not appear to have a corollary in system SRMDs is a waiver renewal. In a waiver renewal that entails no changes to a previously approved waiver (other than a date extension) there is technically no NAS change. This is the case for the Atlanta SRMD. A taxonomy for procedure changes would need to account for the continued application of a previously approved waiver in lieu of a new, explicit change.

The IDA taxonomy for equipment-related NAS changes consists of system acquisitions, modifications, decommissionings/removals, and application of an existing system to a new or modified mission. This equipment-focused breakdown of NAS changes will need to be adapted for procedure changes or augmented by a separate taxonomy. Procedure changes could be viewed in terms of the topics, such as those observed in the sampled SRMDs (e.g., instrument approaches, departure procedures, terminal separation minima, etc.). The drawback to classifying procedure changes by topic is that procedures may not be exclusively addressed by a single topic. Alternatively, procedure changes could be classified according to the “lowest” applicable section or subsection title in FAA Order 7110.65. However, because one change may apply to multiple sections (or multiple orders), this approach also has drawbacks. Additional research is needed to determine what approach, if any, should be used in the IDA to classify procedure changes in some manner that facilitates the AOV’s evaluation of procedure SRMDs, including searches for similar historical SRMDs and NAS changes.

4.3.2 Hazard Analysis Types

The ATO SMS Manual applies to both NAS equipment and ATC procedure-related SRMDs.

According to the ATO SMS Manual dated September 2015, SRM is applied to the provision of air traffic management services, which include “the acquisition, operation, and maintenance of hardware and software; management of airspace and airport facilities; and development of operations and procedures” [18]. Because the same process applies to system equipment and procedure, it follows that the SRMDs for systems and procedures are similar with respect to document structure and basic hazard analysis content. Specifically, the hazard analyses in system and procedure SRMDs include hazards, causes, system state, existing controls, effects, initial risk (severity, likelihood, and associated rationale), recommended safety requirements, and predicted residual risk. There are some hazard analysis worksheet changes between SMS manual versions,

but these changes impact both system and procedure SRMDs in the same manner. For example, the 2015 SMS manual introduces new worksheet columns to capture an explanation of how existing controls were validated and verified; the organization responsible for implementing safety requirements; and safety performance targets that are measureable goals used to verify predicted residual risk.

Additional guidance for system-related SRMDs and procedure changes made in concert with system acquisitions, modifications, and removal are provided in the ATO's Safety Risk Management Guidance for System Acquisitions (SRMGSA) version 2.0, dated September 2014 [19]. The SRMGSA outlines different hazard analysis types, including preliminary, subsystem, system, and operating and support hazard analyses, which apply in a life-cycle SRM process. The SRMDs, including the hazard analyses, are updated over time as a system acquisition or as NAS change transitions from planning through development, implementation, and in-service management. Though the SRMGSA's definition of a system³ includes procedures, certain hazard analysis types are more equipment-focused rather than procedure-focused. For example, subsystem and system hazard analyses examine faults and failures associated with equipment interfaces; an analogous case is not specified for a NAS change involving only ATC procedure updates. Nevertheless, the basic hazard analysis content (regardless of type) conforms to the hazard analysis worksheet structure defined in the SMS manual.

4.3.3 Hazard Types

The sampled procedure SRMDs demonstrate that the hazard types previously defined for equipment SRMDs in the IDA need to be expanded to address some procedure-specific hazards.

The FY15 IDA taxonomy includes equipment, process, human factors, and environmental hazard types. All of these hazard types were exhibited in the sampled procedure SRMDs. In addition, all but two of the sampled procedure-related SRMDs include at least one hazard describing an operational scenario or condition—a new, potential hazard type for the IDA taxonomy. Based on the hazards surveyed, an operational scenario entails aircraft maneuvers, flight paths, or traffic flows. For example, six of the SRMDs identify hazards in which an aircraft blunders into the flight path of another aircraft or into an NTZ, an area between final approach courses in which flight is normally not allowed. It should be noted that certain hazard descriptions are identical or nearly identical (e.g., hazard A80-001 in the Atlanta SRMD and hazard 1 in the Parallel Dependent & Simultaneous Independent Approaches SRMD).

Two SRMDs did not include an operational scenario-based hazard. Both of these SRMDs addressed procedure changes to separation minima given surveillance and automation system capabilities. The ASR-11 3 nmi SRMD proposes the use of terminal separation minima for additional airspace within ASR-11 surveillance coverage. The Honolulu SRMD proposes separation minima changes given Micro-EARTS automation, SSOG adaptation, and a radar

³ According to its stated purpose, the SRMGSA “defines the ATO’s processes for ensuring that systems safety is effectively integrated into system changes and NAS modernization in accordance with FAA orders, the ATO SMS Manual, and AMS [Acquisition Management System] policy” [19]. Systems safety is characterized by the SRMGSA as “an integrated set of constituent pieces” that include “people, equipment, information, procedures, facilities, support, and other services.” Furthermore, safety includes “any technical, social, educational, and/or managerial action initiated to eliminate or reduce the hazards associated with a procedure or system...” according to the SRMGSA.

mosaic backup. Both of these SRMDs contain equipment hazard types and, in the case of the Honolulu SRMD, a human factors hazard.

Only two SRMDs identified human factors hazards, though six SRMDs did include one or more hazard causes that can be classified as human factors. The Los Angeles International Airport (LAX) & Hawthorne Municipal Airport (HHR) Waiver SRMD identifies ATC loss of situational awareness as hazard HHR-01, and the Honolulu SRMD identifies a controller misunderstanding of a Micro-EARTS functionality change in hazard 1. It is anticipated that a larger sample of procedure SRMDs, particularly those that introduce new ATC phraseology/flight crew responsibilities, may yield additional human factors-related hazards. In such cases, it may be necessary to refine the IDA taxonomy to break down human factors into ATC, flight crew, and technical operations roles to accommodate both procedure and equipment NAS changes.

4.3.4 Cause Types

The sampled procedure SRMDs show that the causes identified for equipment SRMDs in the IDA need to be modified to address some procedure-specific factors.

Consistent with hazard types in the FY15 IDA taxonomy, causes are also classified according to equipment, process, human, and environmental types. Except for process, all of these cause types were exhibited in the sampled procedure SRMDs. Six of the sampled procedure SRMDs included at least one equipment cause. These equipment causes mostly address aircraft and ground-system equipment failures and malfunctions. One SRMD (the LAX & HHR Waiver SRMD [17]) identifies two hazards caused by a lack of equipment infrastructure (or coverage), a nuance not accounted for in the equipment cause classifications in the FY15 IDA taxonomy. Six procedure SRMDs also include at least one human factors cause, with nearly all attributed to pilot, ATC, or a non-specified human error. Only one SRMD (the Honolulu SRMD) includes a training deficiency as a hazard cause. Three SRMDs identify environmental causes specifically related to wind and atmospheric conditions.

Because equipment-related SRMDs served as the basis for the FY15 IDA taxonomy, process causes are also equipment-focused, addressing installation faults, adaptation/configuration errors, and testing issues. It follows that these equipment-process cause types do not appear in the sampled procedure SRMDs. These process causes would need to be modified or augmented by a separate classification to address factors related to ATC and flight-crew procedures.

Operational scenarios or conditions can also be used to classify hazard causes in four of the sampled procedure SRMDs. For example, hazard 1 in the Parallel Dependent & Simultaneous Independent Approaches SRMD is caused by a traffic avoidance maneuver. The D10 Waiver SRMD [15] and Atlanta EDO Waiver SRMD [16] also include causes that may be classified as operational scenarios (e.g., less than 3 miles [increasing to 5 miles] separation after the point of flight course divergence in addition to other conditions).

The AOV's REW makes note that SRMD reviewers should pay special attention to single-point failures.⁴ Section 9.1 of the ATO SMS Manual defines a single-point failure as "the failure of an item that would result in the failure of the system and is not compensated for by redundancy or an alternative operational procedure." [18] Though the example of a single-point failure given in the SMS manual is equipment-related, other provisions in the manual extend this concept to procedures. Namely, the manual indicates that a "safe procedure, hardware, or software system requires that the procedure/system contain multiple defenses, ensuring that no single event or sequence of events results in an incident or accident." Four of the sampled procedure SRMDs included hazards with a single cause, specifically the Honolulu and Atlanta SRMDs, the Simultaneous Independent Parallel Approaches SRMD, and the LAX & HHR Waiver SRMD.

Confirming whether these single-cause hazards are indeed single-point failures requires subject matter expertise and a more detailed understanding of the NAS change than what is covered in this study. It should be noted that these single-cause hazards are not limited to equipment faults and failures; training (human factors), environmental conditions, and operational scenarios are also identified as single causes.

4.3.5 Existing Control Types

Existing controls in the sampled procedure SRMDs include a mix of equipment, procedure, training, and other types of controls. Similar to equipment SRMDs, the existing controls identified in the sampled procedure SRMDs also identify procedures at a high level, such as references to the overall FAA Order 7110.65.

All of the sampled procedure SRMDs included at least one existing control that can be classified as equipment and at least one that can be classified as an ATC procedure. The equipment controls cite automation (including conflict alert and minimum safe altitude warning functions, ARTS, and STARS); terminal radar (including ASR-9 and ASR-11); Air Route Surveillance Radar; ASDE-X; airport movement area safety system; instrument landing system backup; required area navigation (RNAV) equipment; ATC/pilot communication and radio equipment; PRM; low-level windshear alert system; airport terminal information system; and aircraft equipment, including traffic alert and collision avoidance system; flight management system; flight deck communication; and onboard weather detection equipment. Procedure existing controls are mostly expressed at a high level (e.g., controls that cite an overall document, such as FAA Order 7110.65; air traffic procedures in general; or ATC or pilot actions such as "air traffic intervention"). Three exceptions are the Atlanta SRMD, which identifies a particular FAA Order 7110.65 section (in the context of a modified procedure cited as an existing control); the Simultaneous Independent Parallel Approaches SRMD, which cites specific sections of Title 14 of the CFR (such as 91.3, Responsibility and Authority of the Pilot in Command); and the LAX & HHR Waiver SRMD, which cites FAA Order 7110.65 Section 5-9-7 c 3 (a), (b), and (c) as an existing control for one hazard.

⁴ See the AOV REW questions 6, 7, and 9 in table 1.

In several cases, equipment and procedures are cited together in one control. For example, hazard A80-001, in the Atlanta SRMD [16], includes an existing control that is an excerpt from associated waiver provisions:

“a. All provisions of FAA Order JO 7110.65. Paragraph 5-9-7. (except the requirements of a3, airport field elevation less than 1,000 feet MSL and a(4)(b) without the use of a high resolution color monitor with alert algorithms, such as the FMA or that required by the PRM program). A80 will use the ASR-9 radar system.”

All sampled procedure SRMDs, except for the ASR-11 3 nmi SRMD, include training in at least one existing control. Similar to how procedure controls are stated, training is also cited at a general level with references to ATC or pilot training without giving a particular topic or training material reference. One exception is the Atlanta SRMD, which has an existing control for hazard A80-001 that “controllers must receive initial training, as well as annual refresher training, on the application of the procedures pertaining to this waiver” [16].

4.3.6 Recommended Safety Requirement Types⁵

The types of recommended safety requirements identified for equipment SRMDs in the IDA need to be expanded to address procedure considerations, such as airspace design.

Four of the sampled procedure SRMDs did not identify any recommended safety requirements; none were technically required because of the initial low risks (or, in one case, medium risk) assessed. One SRMD, the Simultaneous Independent Parallel Approaches SRMD [14], specified no recommended safety requirements but reduced the initial medium risk from 3C to a predicted medium residual risk of 3D.⁶ This SRMD explains that clarifying changes proposed in FAA Order 7110.65 support the risk reduction in the absence of any additional safety requirements.

⁵ The IDA taxonomy applies the same classifications for existing controls and recommended safety requirements.

⁶ The Simultaneous Independent Parallel Approaches SRMD [14] was prepared in accordance with ATO SMS Manual 4.0. SMS Manual 4.0 classifies 3D as a medium risk, whereas versions 2.1 and 3.0 classify 3D as low risk.

Four of the five procedure SRMDs that identified any recommended safety requirements included at least one procedural control. Text from the associated FAA Order 7110.65 procedure change is sometimes specified as a recommended safety requirement, such as in the Honolulu SRMD [10] and D10 Waiver SRMD [15]. Similar to existing procedure controls, recommended procedure controls may also be coupled with equipment requirements. The D10 Waiver SRMD, for example, includes a recommended requirement that:

“a fully operational radar environment must exist at Dallas/Fort Worth International Airport and Dallas Love Field Airport when the procedure is being used, which includes: 1. Standard Instrument Departure System (SIDS), 2. Airport Surveillance Radar (ASR-9)/FUSION Mode...” [15].

Four of the five procedure SRMDs also include at least one training-related recommended safety requirement. Unlike the general references to training in existing controls, recommended training requirements are more specific in the sampled SRMDs. For example, the 3 nmi En Route SRMD [9] recommended a training requirement to “develop an en-route MBI for the application of 3nmi separation between FL 180 and FL 230 which must be completed by all affected en-route operational personnel prior to using this procedure.” In addition, the Honolulu SRMD provides waiver provisions for training as a recommended requirement (i.e., “The facility training manager or FLM must conduct face-to-face briefings with all HCF operational personnel prior to implementation” and “the controller work force must be trained on the proper use of the waiver annually” [10]).

The D10 Waiver SRMD and Atlanta EDO Waiver SRMD include recommended safety requirements related to airspace design or attributes that are not sufficiently described by the procedure classification in the IDA taxonomy. The D10 Waiver SRMD includes recommended requirements for hazard D10-001, which are predicated on the degree of RNAV route divergence and distances between RNAV standard instrument departures. In this case, the recommendation is bundled with waiver provisions, which can be classified as procedures. The recommended requirements for hazard 001 in the Atlanta EDO Waiver SRMD state that performance-based navigation (PBN) “routes diverge by a minimum of 9-degrees in accordance with the current MITRE EDO Study” and “distances between PBN routes are constantly increasing until 5NM lateral separation is established between PBN routes” [11]. The Atlanta EDO Waiver SRMD also includes an operational scenario (a new classification proposed for hazard types) as a recommended safety requirement for the same hazard (i.e., “aircraft are established on PBN routes, and one aircraft has crossed the projected course of the other”). Without additional details, this requirement appears to express a hazardous condition within the context of a recommended safety requirement.

4.3.7 Procedure/System Interdependencies

Procedure/system interdependencies are inherent within the provisions of FAA Order 7110.65. Section text and notes within the Order cite various NAS systems, though the exact relationship between the system and procedure is not necessarily categorized. Observed procedure/system interdependencies include:

- Required system equipment or function (e.g., a procedure can only be conducted when a particular system is present).
 - For example, 5-5-4 states, “Separate aircraft by the following minima: a. TERMINAL. 3. For single sensor ASR-9 with Mode S, when less than 60 miles from the antenna-3 miles.”[5]
- Optional system equipment or function (e.g., a procedure can be conducted if one of the listed systems is operating or one of the listed conditions is met).
 - For example, 5-9-7 includes a provision to “3. Terminate radar monitoring when one of the following occurs: ... (a) Visual separation is applied. (b) The aircraft reports the approach lights or runway in sight. (c)...” [5] This implies that the airport’s approach lighting system does not necessarily have to be operational for this procedure.

Interdependencies between procedures and systems are also established in ATO hazard analysis worksheet data in SRMDs. These interdependencies are identified in the SRMD and include:

- Risk controls (i.e., a system controls the risk of a procedure-related hazard, or vice versa).
- Hazard cause (i.e., a system is identified in a causal factor for a procedure-related hazard, or vice versa).

It is noted that existing controls and recommended safety requirements do not always refer to a specific system name or equipment model. This observation also applies to the equipment-related SRMDs already modeled in the IDA. For example, hazard A80-001 in the Atlanta SRMD outlines existing controls for radar monitoring (both a procedure in FAA Order 7110.65 and an equipment dependency). The person responsible for entering the hazard data into the IDA would need to determine specific equipment to link to that control (e.g., A80 has ASR-9 for terminal radar). This linkage becomes important when future equipment changes (or possible removal) and equipment performance problems need to be examined for impacts to historical hazards, including procedure-related hazards. To assist with SRMD data input, the IDA design may need to consider providing users with a list of facility-specific equipment to guide the selection of equipment links to hazard causes, controls, and recommended safety requirements.

4.3.8 Procedure Correlations

Several types of procedure interrelationships were identified as part of the FAA Order 7110.65 sections and sampled SRMDs. Section text, notes, and references within FAA Order 7110.65 cite

various procedures within the Order and in other documents. As with procedure/system interdependencies, the nature of these procedure citations in the Order are not always explicit; however, certain procedure correlations may be inferred, such as:

- Sequential steps (i.e., one procedure follows another).
- Contingencies (e.g., a procedure is only executed if another procedure fails or does not apply).
- Exceptions (e.g., a procedure is to be used only in specified abnormal conditions or situations).

Correlations among ATC procedures can also be established based on ATO hazard analysis worksheet data in SRMDs. These correlations are explicitly identified in the SRMD and include:

- Risk controls (i.e., a procedure controls the risk of a procedure-related hazard).
- Hazard cause (i.e., a procedure is identified as a causal factor for a procedure-related hazard).

5. IDA MODEL INTEGRATION

5.1 THE FY15 IDA DATA MODEL

The IDA data model developed in FY15 is shown in figure 13. This model identifies the one-to-many and many-to-many relationships among NAS system and SRMD-related data. NAS changes and ATC facilities (also known as service delivery points) are grouped together with system-related data entities. Systems are mapped to performance indicators, such as unavailability and anomaly rates, and interfaces that identify data that are received from or are sent to other systems. SRMD-related data entities capture the hazards, causes, controls, and monitoring tasks associated with an SRMD. Systems are traced to one or more SRMDs and associated hazards via NAS changes; each NAS change reflects the acquisition, modification, or removal of a system. Because systems may cause hazards or control the risk attributed to a hazard, systems are also traced to causes and controls accordingly. Safety indicators, such as control effectiveness and safety influence, are linked to both systems and hazards. Additional details on each data entity and its associated attributes are provided in the draft IDA Model Report [20].

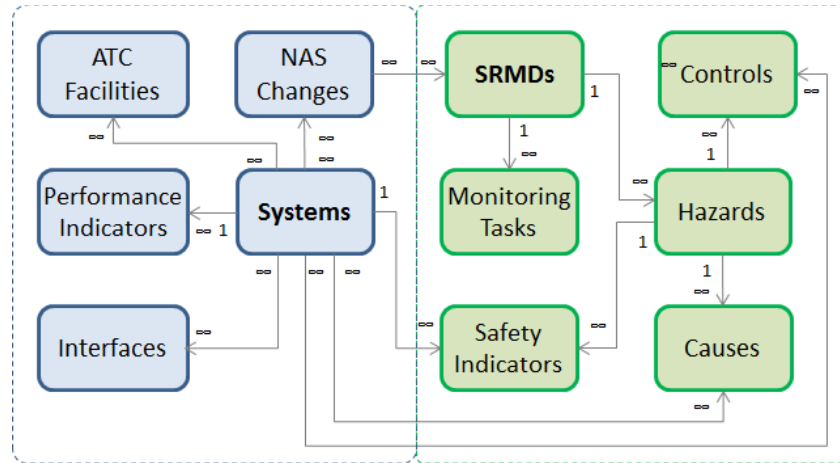


Figure 13. The FY15 IDA data model⁷

5.2 PRELIMINARY MODEL UPDATES

A preliminary concept for the IDA data model updates is shown in figure 14. The updated IDA model introduces new data entities for ATC procedures and actors, references, documents, and indicators related to ATC procedures.

⁷ For simplicity, user-entered remarks, stored reports, and notifications—which may be associated with multiple IDA data entities—are omitted from this view.

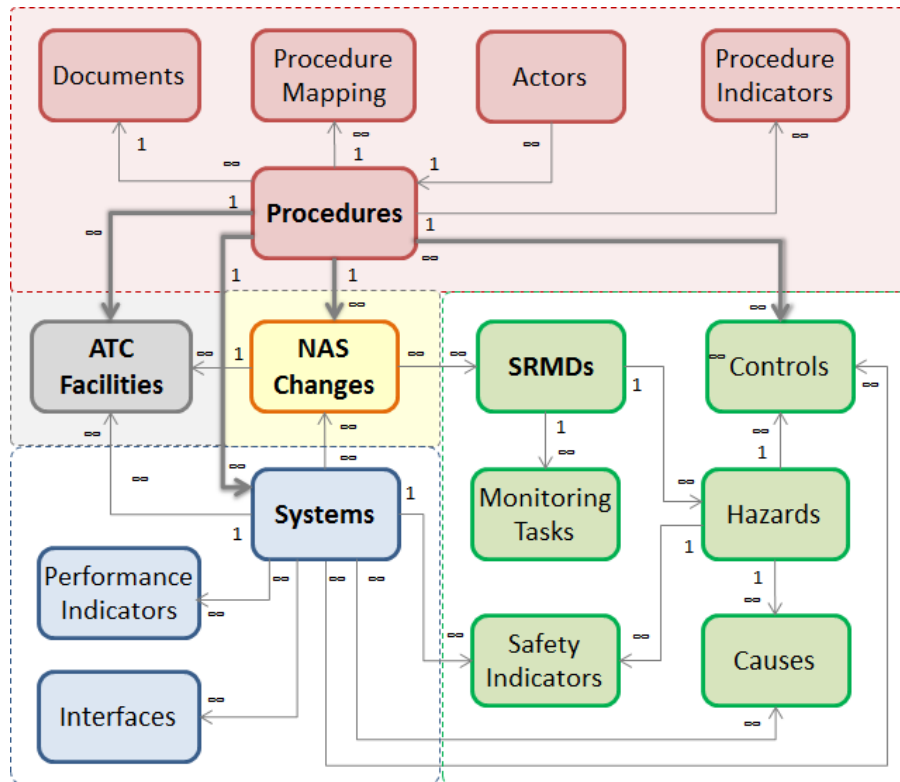


Figure 14. The IDA data model with procedures

A procedure data entity is used to capture the FAA Order 7110.65 chapter and title; section number, title, and text; and associated characteristics discussed in section 3.3. The level of detail at which the IDA should model procedures cannot be determined until a functional analysis and technical approach is developed to meet the AOV needs for ATC procedure SRMD tracking and evaluation. Initially, it is anticipated that the IDA would track procedures at least at the section level (e.g., 5-5-4, 5-5-5, etc.) and possibly the first lettered subsection level (e.g., 5-5-4 a., 5-5-4 b., etc.). In either case, the IDA would need to maintain the structure of FAA Order 7110.65 in terms of chapters that contain sections and sections that contain lettered subsections.

Documents, another data entity, are used to track the FAA Order or other artifact, such as an Advisory Circular that contains multiple procedures. For FAA Order 7110.65, the document data entity may record the Order title, series, change number, and effective date. Because each FAA Order 7110.65 publication cycle introduces multiple procedure changes, managing version information via a document entity is one approach for aligning procedure revisions to a particular series and change number.

A procedure-mapping data entity is used to track links between one procedure and another. As discussed in section 3.3.1, FAA Order 7110.65 annotates procedure links to other procedures. These links are mostly annotated under references; however, additional procedure links are provided in notes and sometimes within procedure text. A manual process and subject matter expertise may be needed to determine procedure links when a particular section number is not given. Whether or not this approach is warranted needs to be examined as part of a future functional analysis of AOV needs for ATC procedure SRMD tracking and evaluation.

An actor data entity could be used to identify the various ATC, flight crew, and other humans in the loop with a role in executing a given procedure. FAA Order 7110.65, Chapter 2, Section 10, which outlines ATC positions and responsibilities for the en route sector, terminal radar/non-radar and tower teams may be used to establish the nomenclature for ATC actors, if needed. Relating procedures to actors may help with identifying whether certain hazard or cause types are overlooked in an SRMD. For example, a procedure change that proposes new phraseology for issuing departure clearances (a tower clearance delivery position responsibility) could be evaluated for identification of hazards involving the actor (i.e., the tower clearance delivery position).

A procedure indicator entity could be developed to support use cases similar to those established for the IDA's system performance and safety indicators. Depending on the specific AOV oversight role (e.g., a management role), indicators may be used to sort and prioritize procedure changes and related hazard data for follow-up oversight, such as audit topic planning. A similar indicator to instability, discussed in section 2.4, could be developed to highlight the number of planned and implemented changes that affect a given procedure over time. For example, because FAA Order Section 5-9-7 procedures are associated with an instability score that is high in comparison to other procedures, the AOV may assemble a team with ATC and flight crew terminal approach expertise to review SRMDs and potential audit topics. Procedure indicators may also be used on a more tactical basis to flag the AOV's oversight attention to abnormal performance or trends, particularly if a procedure change can be linked to operational safety data, such as loss of separation events. An assessment of adapting the IDA's existing system indicators to accommodate ATC procedures is presented in table 5.

Table 5. Adapting the IDA’s system indicators for procedures

System Indicator	Description	Adaptable for Procedures?	Notes
System Safety Influence	Indicates how frequently a system is cited as a risk control or hazard cause.	Yes	Nominal changes to replicate for procedures or remove “system” from indicator title/description.
System Impact	Indicates the relative influence that a system may have on NAS operations and safety. Accounts for interrelationships among systems, hazards, and service delivery points.	Further research required	Major changes for procedures. System dependencies parameter for data interfaces and directionality would need to be removed or replaced with a count of procedure-system interdependencies cited in FAA Order 7110.65, if feasible. System exposure parameter, which is based on system/ATC facility service delivery points, would also need to be removed or replaced by a procedure/domain/facility mapping, if feasible.
NAS Change Impact	Indicates the relative effect that a given change to a NAS system could potentially have on NAS safety given interrelationships with other systems and hazards.	Further research required	Major changes for procedures. See notes for System Safety Influence, which is also a parameter for NAS Change Impact. Also see notes for system dependencies parameter for System Impact. Rules for assessing change complexity and maturity would need to be modified for procedures.
Control Effectiveness	The theoretical capability a set of controls has in achieving the risk level associated with a given hazard.	Yes	Existing parameters include a mix of procedure, system, human, and environmental elements. Scoring methodology would need to be tested using procedure-only and joint procedure/system SRMDs to confirm if any changes are needed.
System Instability	Indicates the number and kind of changes that a system is expected to undergo and the timeframe in which the changes occur.	Yes	Nominal changes to replicate for procedures or remove “system” from indicator title/description. In addition, the taxonomy for NAS change types needs to be extended to procedures (e.g., new, modified, or removed/waived procedures).
System Unavailability	Indicates outage hours for a given system across all ATC SDPs.	No	Not directly applicable to procedures.
System Anomaly Rate	Indicates the number of corrective actions for a given system across all SDPs.	No	Not directly applicable to procedures.

As shown in figure 14, the FY15 IDA data model is restructured to identify ATC facilities and NAS changes as data entities, which are not grouped exclusively with NAS systems. The ATC facilities are serviced by multiple systems, but they are also associated with multiple ATC

procedures. Some ATC procedures apply to all ATC facilities, whereas others apply to a subset of facilities (e.g., en route procedures, which apply to Air Route Traffic Control Centers). In addition, ATC procedures may be waived (i.e., removed) or adapted for one or more facilities. NAS changes, initially modeled for system equipment, can be extended to procedures. Some NAS changes entail both procedures and system equipment, whereas other changes involve only systems or procedures.

Procedures may also be linked to systems required to execute a procedure and existing and recommended risk controls, as discussed in section 4.3.7. Certain procedures explicitly identify system equipment or equipment functions needed to conduct the procedure, as shown in appendix A. Similar to systems, procedures may also serve as risk controls for one or more hazards. The level of specificity in the documented risk control impacts whether that control can be linked to a procedure at a “useful” level. Some SRMDs cite the overall FAA Order 7110.65 (or a particular chapter) as a risk control; this lack of insight into specific procedures by section may limit the utility of tracking such procedure-control links for AOV oversight purposes. Other SRMDs do identify procedure controls according to specific sections (or even subsections) within FAA Order 7110.65.

In the updated IDA data model, procedures and systems are mapped to SRMDs via NAS changes. Given that the ATO SMS Manual identifies a common approach for SRM for both system and procedure (or operational) changes, it follows that SRMDs for systems and procedures are fundamentally similar in structure. As noted in section 4.3, SRMD characteristics, such as hazard types or systems vs. procedures, may vary, but procedure and system SRMDs are sufficiently similar at the abstract data level to be modeled by a common schema. Furthermore, SRMDs may address both systems and procedures when the associated NAS changes entail both, as discussed in section 4.3. Having a common SRMD data entity to address both procedure and system changes may, therefore, be appropriate.

Further analysis is needed to validate whether the preliminary data entities for procedures in figure 14 are necessary to support the AOV’s evaluation of procedure-related SRMDs and other AOV oversight objectives related to ATC procedures. Future IDA R&D plans call for updates to the IDA Concept of Operations (ConOps) following an analysis of AOV oversight needs for ATC procedure SRMD evaluation. This ConOps update will be used to revise the IDA requirements specification and then establish the model and methodology or technical approach for implementation.

The following is a preliminary recommendation for updating the IDA model to integrate procedure data:

- Procedures—A new model and corresponding data entity need to be established for ATC procedures. Concepts for additional procedure-related data entities to model documents, references, and actors are discussed in section 5.2 along with a placeholder to accommodate procedure indicators, as needed. The IDA data schema will also need to model correlations between procedures and interdependencies between procedures and systems, facilities, and risk controls.
- NAS changes—The schema for NAS change types needs to be modified to address joint ATC procedure/system changes and standalone changes to one or the other. From the sampled SRMDs, there are cases in which joint system/procedure changes cannot be decoupled to evaluate an SRMD.
- SRMDs—Procedure- and system-related SRMDs, including hazard analysis data, are sufficiently similar to the model in a single data entity. However, certain SRMD data entity attributes should be modified or added to indicate that the hazard analysis is for new or modified procedures, systems, or both procedures and systems.
- Facilities—ATC facilities should be traceable not only to systems and SRMDs, but also to NAS changes and procedures. Procedures and NAS changes may apply to one or many ATC facilities, and IDA functions used to support SRMD evaluation and data searches need to account for which facilities are linked to a given procedure and NAS change.
- Taxonomy—The ATC procedure SRMDs sampled in this study indicated that the IDA taxonomy updates are needed. Hazard and cause types need to be modified to address operational scenarios observed in the sampled procedure-related SRMDs. Based on the hazards surveyed, an operational scenario entails aircraft maneuvers, flight paths, or traffic flows. Similarly, risk control types, which address both existing and recommended controls, needs to be revised to address airspace design or attributes observed in procedure SRMDs. Human factors sub-classifications for hazards and causes may also need to be decomposed into ATC, flight crew, and technical operations roles so as to accommodate both equipment and procedure NAS changes. Additional taxonomy updates at the sub-classification level are needed, as discussed in section 4.3.

6. CONCLUSIONS AND FUTURE RESEARCH

This report is an overview of FAA Order 7110.65, “Air Traffic Control,” and a sample of SRMDs for proposed changes associated with Section 5-5-4, “Minima,” and Section 5-9-7, “Simultaneous Independent Approaches—Dual & Triple,” within the Order. Key characteristics of the Order and procedure SRMDs are reviewed to identify procedure data that may be modeled in the IDA to evaluate ATC procedure changes. Related SRMDs are also surveyed to examine the types of procedure changes and hazards analysis data that may need to be integrated in the IDA model. As part of this survey, the IDA taxonomy is re-examined to determine the feasibility of addressing not only equipment but also procedure-related NAS changes and SRMDs.

This report presents a concept for modeling ATC procedures in the IDA. The proposed new model for procedures is separate and distinct from the IDA’s system model because (1) the backbone data entities of the two models differ (i.e., one addresses procedure topics and the other addresses NAS

architecture) and (2) new and modified procedures are more complex and extensive than system changes. From just the two sampled procedures (5-5-4, “Minima,” and 5-9-7, “Simultaneous Independent Approaches—Dual & Triple”), multiple changes impacting the same paragraphs are rolled into as many as three changes to a single FAA Order 7110.65 series. One procedure change may be bundled with other procedure changes and new or modified systems addressed by one or more SRMDs, adding to the complexity of the hazard analysis and the AOV’s SRMD evaluation process.

Though separate models for procedures vs. systems are recommended, it is crucial to integrate these models together because of procedure/system interdependencies, as discussed in this report. FAA Order 7110.65 makes extensive references to systems throughout the sampled ATC procedures. In some cases, ATC procedures are predicated on minimum equipment or functionality before they can be implemented. In other cases, procedure variations are outlined based on a range of equipment options. In addition, interdependencies between systems and procedures are established via the hazard-cause and risk-control relationships identified in the SRMDs.

This report concludes that correlations among ATC procedures are inherently more complex than system-to-system relationships. Procedure correlations are annotated throughout FAA Order 7110.65 and refer to other procedures within and outside FAA Order 7110.65. The nature of these procedure interrelationships is not always explicit in the Order. Procedure correlations involve a variety of dynamics, such as sequential steps (i.e., one procedure follows another), contingencies (i.e., a procedure is executed only if another procedure fails or does not apply), and exceptions (i.e., a procedure should only be used in specified abnormal conditions). In comparison, system-to-system dependencies are well-defined in terms of send, send/receive, and receive-only data interfaces.

This report also proposes preliminary updates to existing IDA data-model entities and a new model for procedures. Based on the characteristics of FAA Order 7110.65 and a sample of related SRMDs, the IDA data model updates are proposed to NAS changes, ATC facilities, SRMDs, and systems. Recommended changes to the IDA taxonomy, a fundamental component of the model that enables SRMD evaluation support, are also discussed because the original taxonomy is based on NAS systems and equipment-related SRMDs.

This study concludes that it is feasible to integrate ATC procedures within a common IDA framework that supports the AOV's evaluation of SRMDs for procedure and system changes. A systems engineering process needs to be applied before IDA specification and model updates can be detailed and then validated in terms of necessity and sufficiency. This early assessment of IDA modeling and technical implications can be used to guide future research to extend the IDA concept and data model to integrate ATC procedures. The following considerations support this feasibility assessment and serve as future research guidance:

- Objectives—The AOV's objectives for evaluating procedure SRMDs are the same for system SRMDs. The same criteria are used in the AOV's REW to evaluate the adequacy of procedure and system SRMDs. A hazard analysis being part of a national DCP for FAA Order 7110.65, a facility-specific waiver, or an equipment-focused SRMD does not alter the basic hazard analysis worksheet elements (e.g., hazard description, causes, existing controls, etc.). It follows that the IDA mission to provide decision support for the AOV's evaluation of SRMDs is the same for both procedures and systems.
- Model—By modifying the IDA data model, including the taxonomy, procedures can be captured along with connections to other procedures, NAS changes, systems, facilities, and SRMDs. The hazard, cause, and control types observed in the sampled SRMDs indicate that procedure- and system-related hazard data are sufficiently similar so as to support a common taxonomy for both with the addition of certain procedure-unique elements.
- Design—The IDA's database and software design make it feasible to add any data that can be abstracted and modeled. Techniques to reduce the risk of "breaking" existing software when introducing procedure data and processing logic are discussed in section 5.
- Process—The lead time in which the AOV obtains proposed procedure changes before an AAC decision is required and how much the final change differs from the initial procedure needs to be determined.
- Data Access—Data sources are available for ATC procedures and related changes via AOV Connect and the FAA Order 7100.65 briefing guide section. The same limitations that affect the extraction and input of system architecture data into the IDA apply to procedures. That is, procedure and change information is predominantly in the form of PDF or Microsoft Word documents and must be "data-tized" for integration into the IDA. Procedure SRMD data are also available via AOV Connect, with similar limitations as noted for procedure information. Some procedure SRMD data are also available via the Safety Management Tracking System (SMTS); further investigation is needed to evaluate SMTS data readiness for inclusion in the IDA.
- Data Management—The level of detail in which procedures need to be modeled as individual records (e.g., at the section, lettered subsection, or even lower outline levels) will need to be carefully considered alongside the AOV's search and SRMD evaluation needs to avoid introducing overly complex and voluminous records for data management. The greater the degree of data detail required, the more technical risk introduced in development complexity, integration-readiness, and maintainability. A balance must be determined to provide sufficient data details for AOV objectives.

One of the major challenges the AOV faces in evaluating SRMDs is that hazard analyses focus on individual changes to the NAS. This situation applies to system- and procedure-related SRMDs.

Based on the sample of FAA Order 7110.65 changes and supporting SRMDs examined in this study, procedures and systems are highly interdependent. Understanding and modeling these interdependencies and correlations among ATC procedures is critical to extend the IDA decision support to the AOV's evaluation of procedure and joint system/procedure SRMDs.

This study is a preliminary effort to explore opportunities to expand the IDA's capabilities for equipment-related SRMD evaluation support to procedure-related SRMD evaluation support. Additional research is needed to specify and develop the new procedure model; integrate procedure, system, and SRMD data as part of the IDA framework; and define and implement methodologies to apply the integrated IDA model for combined decision support for AAC and Safety Management Action Review Team oversight activities.

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APPENDIX A—FAA ORDER 7110.65 EXCERPTS

Excerpts from FAA Order 7110.65 Series W, Sections 5-5-4 (“Minima”) and 5-9-7 (“Simultaneous Independent Approaches—Dual & Triple”), are provided in this appendix. Text from both procedures are color-coded in red, blue, and green to denote references to **air traffic domains and facilities**, **system equipment and equipment functions**, and other ATC **procedures**, respectively.

A.1 5-5-4 MINIMA.

FAA Order 7110.65 Series W, Section 5-5-4, addresses required radar separation between aircraft in terminal and en route environments and criteria to minimize wake turbulence hazards.

5-5-4. MINIMA

Separate aircraft by the following minima:

a. *TERMINAL*. Single Sensor ASR or Digital Terminal Automation System (DTAS):

NOTE—

*Includes **single-sensor long-range radar mode**.*

1. When less than 40 miles from the antenna—*3 miles*.
2. When 40 miles or more from the antenna—*5 miles*.
3. For single sensor **ASR-9 with Mode S**, when less than 60 miles from the antenna—*3 miles*.
4. For single sensor **ASR-11 MSSR Beacon**, when less than 60 miles from the antenna—*3 miles*.

NOTE—

***Wake turbulence procedures** specify increased separation minima required for certain classes of aircraft because of the possible effects of wake turbulence.*

b. *TERMINAL*. FUSION:

1. Fusion target symbol—*3 miles*.
2. When displaying ISR in the data block—*5 miles*.

NOTE—

In the event of an unexpected ISR on one or more aircraft, the ATCS working that aircraft must transition from 3-mile to 5-mile separation or establish some other form of approved separation (visual or vertical) as soon as feasible. This action must be timely but taken in a reasonable fashion, using the controller’s best judgment, as not to reduce safety or the integrity of the traffic situation. For example, if ISR appears when an aircraft is established on final with another aircraft on short final, it would be beneficial from a safety perspective to allow the trailing aircraft to continue the approach and land rather than terminate a stabilized approach.

3. If TRK appears in the data block, handle in accordance with Paragraph 5-3-7, Identification Status, Subparagraph b, and take appropriate steps to establish non-radar separation.

4. ADS-B may be integrated as an additional surveillance source when operating in FUSION mode. The display of ADS-B targets is permitted and does not require radar reinforcement.

NOTE—

ADS-B surveillance must only be used when operating in FUSION.

5. The use of ADS-B-only information may be used to support all radar requirements associated with any published instrument procedure that is annotated “Radar Required.”

6. The ADS-B Computer Human Interface (CHI) may be implemented by facilities on a sector-by-sector or facility-wide basis when the determination is made that utilization of the ADS-B CHI provides an operational advantage to the controller.

c. EBUS, Terminal Mosaic/Multi-Sensor Mode:

NOTE—

Mosaic/Multi-Sensor Mode combines radar input from 2 to 16 sites into a single picture utilizing a mosaic grid composed of radar sort boxes.

1. Below FL 600—5 miles.

2. At or above FL 600—10 miles.

3. Facility directives may specify 3 miles for areas meeting all of the following conditions:

(a) Radar site adaptation is set to single sensor.

(b) Significant operational advantages can be obtained.

(c) Within 40 miles of the antenna.

(d) Up to and including FL 230.

(e) Facility directives specifically define the area where the separation can be applied and can define the requirements for displaying the area on the controller’s display.

REFERENCES—

FAAO JO 7210.3, Para 8-2-1, Three Mile Airspace Operations

FAAO JO 7210.3, Para 11-8-15, Single Site Coverage ATTS Operations

4. When transitioning from terminal to en-route control, 3 miles increasing to 5 miles or greater, provided:

(a) The aircraft are on diverging routes/courses; and/or

(b) The leading aircraft is and will remain faster than the following aircraft; and

(c) Separation is constantly increasing and the first center controller will establish 5 NM or another appropriate form of separation prior to the aircraft departing the first center sector; and

(d) The procedure is covered by a letter of agreement between the facilities involved and limited to specified routes/sectors/positions.

d. ERAM:

1. Below FL 600—*5 miles*.

2. At or above FL 600—*10 miles*.

3. Below FL 230 where all the following conditions are met—*3 miles*:

(a) Significant operational advantages can be obtained.

(b) Within 40 miles of the preferred sensor and within the 3 NM separation area.

(c) The preferred sensor is providing reliable beacon targets.

(d) Facility directives specifically define the 3 NM separation area.

(e) The 3 NM separation area is displayable on the video map.

(f) Involved aircraft are displayed using the 3 NM target symbol.

4. When transitioning from terminal to en-route control, 3 miles increasing to 5 miles or greater, provided:

(a) The aircraft are on diverging routes/courses; and/or

(b) The leading aircraft is and will remain faster than the following aircraft; and

(c) Separation constantly increasing and the first center controller will establish 5 NM or other appropriate form of separation prior to the aircraft departing the first center sector; and

(d) The procedure is covered by a letter of agreement between the facilities involved and limited to specified routes/sectors/positions.

REFERENCES—

FAAO JO 7210.3, Para 8-2-1, Three Mile Airspace Operations
FAAO JO 7210.3, Para 11-8-15, Single Site Coverage ATTS Operations

e. MEARTS Mosaic Mode:

1. Below FL 600—*5 miles*.

2. At or above FL 600—*10 miles*.

3. For areas meeting all of the following conditions—*3 miles*:

(a) Radar site adaptation is set to single-sensor mode.

NOTE—

1. *Single-Sensor Mode* displays information from the *radar* input of a single site.
2. Procedures to convert *MEARTS Mosaic Mode* to *MEARTS Single-Sensor Mode* at each *PVD/MDM* will be established by facility directive.

- (b) Significant operational advantages can be obtained.
- (c) Within 40 miles of the antenna.
- (d) Below FL 180.
- (e) Facility directives specifically define the area where the separation can be applied and define the requirements for displaying the area on the controller's *PVD/MDM*.

4. *MEARTS Mosaic Mode* Utilizing Single Source Polygon (*San Juan CERAP and Honolulu Control Facility only*) when meeting all of the following conditions—3 miles:

- (a) Less than 40 miles from the antenna, below FL180, and targets are from the *adapted sensor*.
- (b) The single-source polygon must be displayed on the controller's *PVD/MDM*.
- (c) Significant operational advantages can be obtained.
- (d) Facility directives specifically define the single-source polygon area where the separation can be applied and specify procedures to be used.
- (e) Controller must commence a transition to achieve either vertical separation or 5-mile lateral separation in the event that either target is not from the adapted sensor.

f. *STARS Multi-Sensor Mode*:

NOTE—

1. In *Multi-Sensor Mode*, *STARS* displays targets as filled and unfilled boxes, depending upon the target's distance from the *radar* site providing the data. Since there is presently no way to identify which specific site is providing data for any given target, use separation standards for targets 40 or more miles from the antenna.
2. When operating in *STARS Single-Sensor Mode*, if TRK appears in the data block, handle in accordance with *para 5-3-7, Identification Status, subpara b*, and take appropriate steps to establish *nonradar separation*.
3. TRK appears in the data block whenever the aircraft is being tracked by a *radar* site other than the radar currently selected. Current equipment limitations preclude a target from being displayed in the single-sensor mode; however, a position symbol and data block, including altitude information, will still be displayed. Therefore, low-altitude alerts must be provided in accordance with *para 2-1-6, Safety Alert*.

WAKE TURBULENCE APPLICATION

- g. Separate aircraft operating directly behind or following an aircraft conducting an instrument approach by the minima specified and in accordance with the following:

NOTE—

Consider parallel runways less than 2500 feet apart as a single runway because of the possible effects of wake turbulence.

1. When operating within 2500 feet of the flight path of the leading aircraft over the surface of the earth and less than 1,000 feet below:

- (a) **TERMINAL**. Behind super:

(1) Heavy—6 miles.

(2) Large—7 miles.

(3) Small—8 miles.

- (b) **EN ROUTE**. Behind super—5 miles, unless the super is operating at or below FL240 and below 250 knots, then:

(1) Heavy—6 miles.

(2) Large—7 miles.

(3) Small—8 miles.

- (c) Behind heavy:

(1) Heavy—4 miles.

(2) Large or small—5 miles.

2. Separate small aircraft behind a B757 by 4 miles when operating within 2500 feet of the flight path of the leading aircraft over the surface of the earth or less than 500 feet below.

3. **TERMINAL**. When departing parallel runways separated by less than 2500 feet, the 2500 feet requirement in **subparagraph 2** is not required when a small departs the parallel runway behind a B757. Issue a wake turbulence cautionary advisory and instructions that will establish lateral separation in accordance with **subparagraph 2**. Do not issue instructions that will allow the small to pass behind the B757.

NOTE—

*The application of **paragraph 5-8-3, Successive or Simultaneous Departures**, satisfies this requirement when an initial heading is issued with the takeoff clearance.*

WAKE TURBULENCE APPLICATION

- h. In addition to subpara g, separate an aircraft landing behind another aircraft on the same runway, or one making a touch-and-go, stop-and-go, or low approach by ensuring the following minima will exist at the time the preceding aircraft is over the landing threshold:

NOTE—

Consider parallel runways less than 2500 feet apart as a single runway because of the possible effects of wake turbulence.

1. Small behind large—4 miles.
2. Small behind heavy—6 miles.

If the landing threshold cannot be determined, apply the above minima as constant or increasing at the closest point that can be determined prior to the landing threshold.

- i. **TERMINAL**. When NOWGT is displayed in an aircraft data block, provide 10 miles separation behind the preceding aircraft and 10 miles separation to the succeeding aircraft.
- j. **TERMINAL**. 2.5 nautical miles (NM) separation is authorized between aircraft established on the final approach course within 10 NM of the landing runway when operating in [single-sensor slant range mode](#) and aircraft remains within 40 miles of the antenna and:

1. The leading aircraft's weight class is the same or less than the trailing aircraft;
2. Super and heavy aircraft are permitted to participate in the separation reduction as the trailing aircraft only;
3. An average runway occupancy time of 50 seconds or less is documented;
4. [CTRDs](#) are operational and used for quick glance references;

REFERENCES—

FAAO JO 7110.65, Para 3-1-9, Use of Tower Radar Displays

5. Turnoff points are visible from the control tower.

REFERENCES—

FAAO JO 7110.65, Para 2-1-19, Wake Turbulence
FAAO JO 7110.65, Para 3-9-6, Same Runway Separation
FAAO JO 7110.65, Para 5-5-7, Passing or Diverging
FAAO JO 7110.65, Para 5-5-9, Separation from Obstructions
FAAO JO 7110.65, Para 5-8-3, Successive or Simultaneous Departures
FAAO JO 7110.65, Para 5-9-5, Approach Separation Responsibility
FAAO JO 7110.65, Para 7-6-7, Sequencing
FAAO JO 7110.65, Para 7-7-3, Separation
FAAO JO 7110.65 Para 7-8-3, Separation
FAAO JO 7210.3, Para 10-4-11, Reduced Separation on Final

A.2 5-9-7 SIMULTANEOUS INDEPENDENT APPROACHES—DUAL & TRIPLE

FAA Order 7110.65 Series W, Section 5-9-7 addresses requirements for conducting simultaneous independent approaches in the terminal environment.

5-9-7. SIMULTANEOUS INDEPENDENT APPROACHES—DUAL & TRIPLE

TERMINAL

a. Apply the following minimum separation when conducting simultaneous independent approaches:

1. Provide a minimum of 1000 feet vertically or a minimum of 3 miles **radar** separation between aircraft during turn-on to parallel final approach.

NOTE—

1. *During triple parallel approaches, no two aircraft will be assigned the same altitude during turn-on. All three aircraft will be assigned altitudes which differ by a minimum of 1000 feet. Example: 3000, 4000, 5000; 7000, 8000, 9000.*
2. ***Communications** transfer to the tower controller's frequency must be completed prior to losing vertical separation between aircraft.*
2. Dual parallel runway centerlines are at least 3600 feet apart, or dual parallel runway centerlines are at least 3000 feet apart with a 2.5° to 3.0° offset approach to either runway, and the airport field elevation is 2000 feet MSL or less.

NOTE—

Airport field elevation requirement does not apply to dual parallel runways that are 4300 feet or more apart.

3. Triple parallel approaches may be conducted under one of the following conditions:

- (a) Parallel runway centerlines are at least 3900 feet apart, and the airport field elevation is 2000 feet MSL or less; or
- (b) Parallel runway centerlines are at least 3000 feet apart, a 2.5° to 3.0° offset approach to both outside runways, and the airport field elevation is 2000 feet MSL or less; or
- (c) Parallel runway centerlines are at least 3000 feet apart, a single 2.5° to 3.0° offset approach to either outside runway, whereas parallel approaches to the remaining two runways are separated by at least 3900 feet, and the airport field elevation is 2000 feet MSL or less.

4. Provide the minimum applicable **radar** separation between aircraft on the same final approach course.

b. A **high-resolution color monitor with alert algorithms**, such as the **final monitor aid** or that required in the **precision runway monitor** program must be used to monitor approaches for which:

1. Dual parallel runway centerlines are at least 3000 and no more than 4300 feet apart.
2. Triple parallel runway centerlines are at least 3000 but less than 5000 feet apart, and the airport field elevation is 2000 feet MSL or less.

3. Triple parallel approaches to airports where the airport field elevation is more than 2000 feet MSL require use of the [FMA system](#) and an approved FAA aeronautical study.

NOTE—

FMA is not required to monitor the NTZ for runway centerlines greater than 4300 feet for dual runways, and 5000 feet or greater for triple operations.

- c. [FUSION](#) must be discontinued on the [FMA displays](#) and set to a [single-sensor](#) when conducting final monitoring activities.

REFERENCES—

FAAO JO 7110.65, Para 5-5-4, Minima.

- d. The following conditions must be met when conducting dual or triple simultaneous independent approaches:

NOTE—

Simultaneous independent approaches may be conducted only where instrument approach charts specifically authorize simultaneous approaches.

REFERENCES—

FAAO JO 7210.3, Para 10-4-6, Simultaneous Approaches (Dependent/Independent).

1. Straight-in landings will be made.
2. All appropriate [communication, navigation, and surveillance systems](#) are operating normally.
3. Inform aircraft that simultaneous independent approaches are in use, or when runway centerlines less than 4300 feet PRM approaches are in use, prior to aircraft departing an outer fix. This information may be provided through the [ATIS](#).

REFERENCES—

P/CG Term—Precision Runway Monitor System.

4. Clear the aircraft to descend to the appropriate [glideslope](#)/glidepath intercept altitude soon enough to provide a period of level flight to dissipate excess speed. Provide at least 1 mile of straight flight prior to the final approach course intercept.

NOTE—

Not applicable to approaches with RF legs.

5. An NTZ of at least 2000 feet wide is established at an equal distance between extended runway final approach courses and must be depicted on the [monitor display](#). The primary responsibility for navigation on the final approach course rests with the pilot. Control instructions and information are issued only to ensure separation between aircraft and to prevent aircraft from penetrating the NTZ.
6. Monitor all approaches regardless of weather. Monitor local [control frequency](#) to receive any aircraft transmission. Issue control instructions as necessary to ensure aircraft do not enter the NTZ.

NOTE—

1. Separate monitor controllers, each with *transmit/receive and override capability* on the local control frequency, must ensure that aircraft do not penetrate the depicted NTZ. Facility directives must define responsibility for providing the minimum applicable longitudinal separation between aircraft on the same final approach course.
2. The aircraft is considered the center of the *primary radar* return for that aircraft, or, if an *FMA or other color final monitor aid* is used, the center of the digitized target of that aircraft, for the purposes of ensuring an aircraft does not penetrate the NTZ. The provisions of *para 5-5-2, Target Separation*, apply also.

e. The following procedures must be used by the final monitor controllers:

1. Instruct the aircraft to return to the correct final approach course when aircraft are observed to overshoot the turn-on or to continue on a track that will penetrate the NTZ.

PHRASEOLOGY—

YOU HAVE CROSSED THE FINAL APPROACH COURSE. TURN (left/right) IMMEDIATELY AND RETURN TO THE FINAL APPROACH COURSE,

or

TURN (left/right) AND RETURN TO THE FINAL APPROACH COURSE.

2. Instruct aircraft on the adjacent final approach course to alter course to avoid the deviating aircraft when an aircraft is observed penetrating or, in your judgment, will penetrate the NTZ.

PHRASEOLOGY—

TRAFFIC ALERT (call sign), TURN (right/left) IMMEDIATELY HEADING (degrees), CLIMB AND MAINTAIN (altitude).

3. Terminate *radar* monitoring when one of the following occurs:

(a) Visual separation is applied.

(b) The aircraft reports the *approach lights* or runway in sight.

(c) The aircraft is 1 mile or less from the runway threshold, if procedurally required and contained in facility directives.

4. Do not inform the aircraft when radar monitoring is terminated.

5. Do not apply the provisions of *Paragraph 5-13-1, Monitor on PAR Equipment*, for simultaneous independent approaches.

f. Consideration should be given to known factors that may in any way affect the safety of the instrument approach phase of flight when simultaneous independent approaches are being conducted to parallel runways. Factors include, but are not limited to, wind direction/velocity, *windshear alerts*/reports, severe weather activity, etc. Closely monitor weather activity that could impact the final approach course. Weather conditions in the vicinity of the final approach course may dictate a change of approach in use.

REFERENCES-

FAAO JO 7110.65, Para 5-1-13, Radar Service Termination.

FAAO JO 7110.65, Para 5-9-2, Final Approach Course Interception.

APPENDIX B—ANNOTATED HAZARD ANALYSIS WORKSHEET DATA

Table B-1 includes hazard analysis worksheet data for nine procedure-related Safety Risk Management Documents (SRMDs) sampled for changes to FAA Order 7110.65 Sections 5-5-4 and 5-9-7.

The first column references the SRMD number given in section 4 in this report and does not correspond to any identifiers within the SRMD. The second column provides the hazard number as cited in the actual SRMD. Columns 3–6 provide hazard descriptions, causes, existing controls, and recommended safety requirements, which are annotated and re-ordered from the original SRMD according to type (denoted in bold and parentheses). The annotated types of hazards, causes, controls, and safety requirements are based on the FY15 Integrated Domain Assessment taxonomy and proposed updates, as described in section 4 in this report. Finally, the last column provides the initial and predicted residual risk, as assessed in the SRMD.

APPENDIX B—LIST OF ACRONYMS

AMASS	Airport Movement Area Safety System
ARSR	Air Route Surveillance Radar
ARTS	Automated Radar Terminal System
ASDE-X	Airport Surface Detection Equipment—Model X
ASR	Airport surveillance radar
AT	Air Traffic
ATC	Air traffic control
ATCR	Air Traffic Control Radio
ATIS	Automatic Terminal Information Service
ATO	Air Traffic Organization
ATO-T	Air Traffic Organization - Terminal
ATC	Air traffic control
CFR	Code of Federal Regulations
CRM	Crew resource management
DAL	Dallas Love Field Airport
DFW	Dallas/Fort Worth International Airport
ETG	Enhanced Target Generator
FCT	Federal Contract Tower
FL	Flight level
FLM	Front-line manager
FMS	Flight Management System
HCF	Honolulu Control Facility
HHR	Hawthorne Municipal Airport
ILS	Instrument Landing System
KDAL	Dallas-Love Field
LAX	Los Angeles International Airport
LLWAS	Low Level Windshear Alert System
LOA	Letter of Agreement
MBI	Mandatory briefing item
MSAW	Minimum safe altitude warning
MSSR	Monopulse Secondary Surveillance Radar
NEMACS	New England Mid-Air Collision Avoidance Seminar
NOTAM	Notice to Airmen
NTZ	No-Transgression Zone
PBN	Performance-based navigation
PM	Parallel monitor
RNAV	Area Navigation
RNP	Required Navigation Performance
SCT	Southern California TRACON
SID	Standard Instrument Departure
SOP	Standard operating procedure
SRMD	Safety Risk Management Document
SSOG	Single source area
STARS	Standard Terminal Automation Replacement System

TCAS	Traffic Alert and Collision Avoidance System
TMI	Traffic Management Initiative
VFR	Visual flight rules
ZFW	Dallas Ft. Worth ARTCC

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
1	1	Applying 3 nm separation from FL 180 to FL 230 (Reduced separation with higher airspeed) (Operational Scenario)	Pilot deviation or controller error Less time to react (Human Factors)	Automation Terminal Radar with sweep rate of one sweep per 4.6 second preferred, because it reduces the likelihood of collision by an order of magnitude, but ARSR with 12 seconds per sweep is still good. (Equipment) 7110.65 7210.3 (Procedures) Training (OJT, briefings) (Training)	Develop an En Route mandatory briefing item (MBI) for the application of 3nm separation between FL 180 and FL 230 which must be completed by all affected En Route operational personnel prior to using this procedure. (Training)	Initial: 4C Residual: 4C

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
2	1	A controller misunderstands or is unaware of the functionality change (Human Factors)	Inadequate controller training (Training)	Visual indication of target color and indicator (Equipment) AT procedures developed (Procedures) Controller training / briefing (Training)	All special provisions, conditions, and limitations listed in Section 8 of this SRMD and the requested waiver –Operations conducted under this waiver are subject to the following: a. This waiver is limited to aircraft operations in the HCF SSOG within 40 nautical miles (NM) of the Maui radar antenna below flight level 180. b. A minimum 3 NM separation standard must be applied between two targets within 40 NM from the Maui radar antenna and below FL180 in the HCF SSOG if the targets are: 1. Two green beacon slashes. 2. Two green primaries. 3. One green beacon slash and one green primary. c. A minimum 5 NM separation standard must be applied between the following within 40 NM from the Maui radar antenna and below FL180 in the HCF SSOG: 1. Two white beacon slashes with a white circle around them. 2. Two white primaries with a while circle around them. 3. A green beacon slash and a white beacon slash with a while circle around it. 4. A green beacon slash and a while primary with a while circle around it. 5. A green primary and a white beacon slash with a white circle around it. 6. A green primary and a white primary with a white circle around it. d. When using the special procedures covered under this waiver, a video map must be displayed identifying the lateral limits of the Single Source capability. (Equipment, Procedures) e. The provisions, conditions and limitations of requested waiver will be incorporated into HCF Order 7110.XX, Procedures for use of the Single Source Area R9/10 for Kahului airport Area. (Procedures) f. The facility training manager or FLM must conduct face-to-face briefings with all HCF operational personnel prior to implementation. g. The controller work force must be trained on the proper use of the waiver annually. (Training)	Initial: 3D Residual: 3D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
2	2	The software change could adversely affect another function of the program resulting in a coding conflict with existing code that could produce an unexpected outcome (Equipment)	Coding oversight (Equipment, Process)	S/W design, code & tests reviewed by independent analyst Change thoroughly tested Fallback procedure in place (Procedures)	All special provisions, conditions, and limitations listed in Section 8 of this SRMD and the requested waiver –Operations conducted under this waiver are subject to the following: a. This waiver is limited to aircraft operations in the HCF SSOG within 40 nautical miles (NM) of the Maui radar antenna below flight level 180. b. A minimum 3 NM separation standard must be applied between two targets within 40 NM from the Maui radar antenna and below FL180 in the HCF SSOG if the targets are: 1. Two green beacon slashes. 2. Two green primaries. 3. One green beacon slash and one green primary. c. A minimum 5 NM separation standard must be applied between the following within 40 NM from the Maui radar antenna and below FL180 in the HCF SSOG: 1. Two white beacon slashes with a white circle around them. 2. Two white primaries with a while circle around them. 3. A green beacon slash and a white beacon slash with a while circle around it. 4. A green beacon slash and a while primary with a while circle around it. 5. A green primary and a white beacon slash with a white circle around it. 6. A green primary and a white primary with a white circle around it. d. When using the special procedures covered under this waiver, a video map must be displayed identifying the lateral limits of the Single Source capability. (Equipment, Procedures) e. The provisions, conditions and limitations of requested waiver will be incorporated into HCF Order 7110.XX, Procedures for use of the Single Source Area R9/10 for Kahului airport Area. (Procedures) f. The facility training manager or FLM must conduct face-to-face briefings with all HCF operational personnel prior to implementation. g. The controller work force must be trained on the proper use of the waiver annually. (Training)	Initial: 5D Residual: 5D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
3	A80-001 Para 5-9-7a4(b)	Aircraft blunders into NTZ (Operational Scenario)	Equipment malfunction (Equipment) Human error (Human Factors) Weather (Environmental)	<p>Radar monitoring</p> <p>Frequency override capability</p> <p>Aircraft equipment capabilities (Equipment)</p> <p>Controller intervention (Procedures)</p> <p>All special provisions, conditions and limitations as listed in the existing waiver - Operations conducted under this waiver are subject to the following:</p> <ol style="list-style-type: none"> All provisions of FAA Order JO 7110.65. Paragraph 5-9-7. (except the requirements of a3, airport field elevation less than 1,000 feet MSL and a(4)(b) without the use of a high resolution color monitor with alert algorithms, such as the final monitor aid or that required by the precision runway monitor program). Atlanta TRACON (A80) will use the ASR-9 radar system. (Equipment, Procedures) Aircraft breakout procedures must be accomplished in accordance with the Pullout Procedures established in the A80 SOP 7110.65. The provisions of this waiver must be documented in, and implemented through, local facility directives. Facility directives must define the position responsible for providing the minimum applicable longitudinal separation between aircraft on the same final approach course. (Procedures) Controllers must receive initial training, as well as annual refresher training, on the application of the procedures pertaining to this waiver. (Training) f. ATO-T must be immediately advised of any temporary or permanent change that would affect the relative conditions of this waiver. (Procedures) 	Requirements in the existing waiver are sufficient	Initial: 3D Residual: 3D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
3	A80-002 Para 5-9-7(a)3	Aircraft performance at field elevations 1000' or greater (Equipment, Operational Scenario)	Airport elevation (1026') (Environmental)	None required	Requirements in the existing waiver are sufficient	Initial: 5E Residual: 5E
4	ASR11-1	Loss of single beacon presentation on controller's display between 40 and 60 NM from ASR-11 antenna (Equipment)	Aircraft equipment malfunction Automation system malfunction MSSR malfunction (Equipment) Human error – transponder inadvertently turned off (Human Factors)	Equipment reliability standards and error specifications Equipment redundancy (Equipment) Equipment certification and periodic maintenance procedures Flight crew regulations and procedures FAA Order 7110.65 FAA Order 6310.30A Local SOPs/LOAs (Procedures)	No additional safety requirements	Initial: 5C Residual: 5C
4	ASR11-2	Loss of multiple beacon presentations on controller's display between 40 and 60 NM from ASR-11 antenna (Equipment)	Automation system malfunction MSSR malfunction (Equipment) Human error – MSSR inadvertently turned off (Human Factors)	Equipment reliability standards and error specifications Equipment redundancy (Equipment) Equipment certification and periodic maintenance procedures Flight crew regulations and procedures FAA Order 7110.65 FAA Order 6310.30A Local SOPs/LOAs (Procedures)	No additional safety requirements	Initial: 4D Residual: 4D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
5	1	Blunder into NTZ (Operational Scenario)	Navigation and flight technical errors (pilots) pilot/controller error (Human Factors) ground based or equip fail (Equipment) Wx/wind-shear (Environmental) Traffic avoidance maneuver (Operational scenario)	Radar monitor CA PRM TCAS LLWAS (Equipment) Aircraft/aircrew alert and monitoring of nav equip using RNAV criteria Vis separation Procedure design (Procedures) Pilot/controller training (Training)	No requirement to mitigate further	Initial: 4D Residual: Low
5	2	Loss of aircraft navigation capability (Equipment)	Poor GPS signal or constellation configuration Loss of GPS signal (Equipment) Atmospheric and/or space conditions (Environmental)	Dual avionics ILS backup Radar monitoring (Equipment)	No requirement to mitigate further	Initial: 5D Residual: Low

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
6	SIPIA-01	Inadvertently blundering into flight path of another aircraft (Operational Scenario)	Loss of communication (Equipment)	14 CFR 121.347, Communication and navigation equipment for VFR 14 CFR 125.203, Communication and navigation equipment 14 CFR 135.165, Communication and navigation equipment Traffic Alert and Collision Avoidance System (TCAS) Conflict Alert Flight Management System (FMS) (Equipment) 14 Code of Federal Regulations (CFR) 91.3, Responsibility and authority of the pilot in command 14 CFR 91.101, Applicability 14 CFR 121.349, IFR operations over the top Facility Standard Operating Procedure (SOP) Supervisor Visual Observation (Procedures) Pilot/Controller intervention and training (Training)	None.	Initial: 1E Residual: 1E
6	SIPIA-02	Aircraft overshoots final approach course into flight path of another aircraft (Operational Scenario)	Loss of communication (Equipment) Pilot/Controller error Wrong localizer frequency / runway loaded into FMS Pilot/controller reaction time lag (Human Factors) Strong tail wind (Environmental)	14 CFR R 121.347, Communication and navigation equipment for VFR 14 CFR 125.203, Communication and navigation equipment 14 CFR 135.165, Communication and navigation equipment TCAS (Equipment) FAA Order 7110.65, 5-7-9 Requirement for vertical separation during turn onto final 14 CFR 91.3, Responsibility and authority of the pilot in command 14 CFR 91.101, Applicability 14 CFR 121.349, IFR operations over the top Commercial Operator Operations Specifications (OPSSPECS) (Procedures) Pilot/Controller intervention and training (Training)	None.	Initial: 3C Residual: 3D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
6	SIPIA-03	Course deviation on missed approach into the flight path of another aircraft also on a missed approach (Operational Scenario)	Strong crosswind (Environmental) Pilot error (Human Factors)	TCAS On-board weather detection (Equipment) 14 CFR 91.175, Takeoff and landing under IFR (Procedures) Pilot/Controller intervention and Training (Training)	None.	Initial: 4D Residual: 4D
7	D10-001	Aircraft potentially operates with less than prescribed separation during the transition phase from terminal airspace to en route airspace (Operational Scenario)	After the point of divergence there could be: Less than 15 degrees divergence, Less than three increasing to 5 miles separation, Faster aircraft trailing (Operational Scenario)	Accuracy of RNAV equipment RNP values, integrity checks by pilots, certification requirements (Equipment, Procedures) Traffic Alert and Collision Avoidance System (TCAS) (Equipment) Off-the-ground RNAV phraseology Pilot/controller intervention SOP for controllers and pilots LOA between D10 and ZFW (Procedures) Pilot/controller training (Training)	Special provisions as listed in waiver application: Operations conducted under this waiver are subject to the following provisions: a. a. A fully operational radar environment must exist at DFW and DAL when the procedure is being utilized which includes: 1. Standard Instrument Departure System (SIDS) 2. Airport Surveillance Radar (ASR-9)/FUSION Mode b. NOTE: When any of these components fail the waived operations must cease until such time the equipment is operational. (Equipment, Procedures) c. RNAV routes diverge by a minimum of 10 degrees. The minimum distance between waypoints on the RNAV procedures at the D10 airspace boundary is five miles. (Airspace) d. Lateral separation of three miles must be maintained until the lead aircraft is 2-miles past the diverge point and established on the RNAV route prior to the diverge point. e. Distances between RNAV SIDs are constantly increasing until 5NM lateral or other appropriate form of separation is established and prior to exiting the first sector within ZFW ARTCC. (Airspace, Procedures) f. The procedure and separation criteria mentioned above is covered by a Letter of Agreement (LOA) between the facilities involved and limited to specific routes, sectors, and positions. f. Either facility may discontinue the use of this waiver after coordination with the other facility. (Procedures) g. All Air Traffic Control personnel must be trained on these special procedures prior to implementation and again annually. (Training) h. The waiver will only apply to successive departures off DFW and Dallas-Love Field (KDAL) separately, and not between aircraft departing separate airports. (Procedures)	Initial: 5D Residual: 5D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
8	001	Aircraft potentially operating with less than 3 miles standard radar separation during the transition phase from Terminal to En Route (Operational Scenario)	After the point of divergence: 1. Less than 15 degrees divergence 2. Less than 3 increasing to 5 miles separation 3. Faster aircraft can be trailing. 4. Path deviation (Operational Scenario)	Accuracy of RNAV equipment RNP values, integrity checks by pilots, certification requirements (Equipment, Procedures) TCAS -safety logic (Equipment) Pilot/controller awareness and intervention as required Standard operating procedures for controllers and pilots, LOA and internal guidance will clearly establish the application of procedure. (Procedures) Pilot/controller training (Training)	Aircraft are established on PBN routes and one aircraft has crossed the projected course of the other; (Operational Scenario) PBN routes diverge by a minimum of 9-degrees in accordance current MITRE EDO Study; Distances between PBN routes are constantly increasing until 5NM lateral separation is established between PBN routes; (Airspace) Terminal controllers ensure that the primary targets, beacon control slashes, or full digital terminal system primary and/or beacon target symbols will not touch; and The procedure is covered by an LOA between the facilities involved and limited to specific routes and/or sectors/positions. (Procedures)	Initial: 4D Residual: 4D
9	HHR-01	Loss of Situational Awareness by ATC (Human Factors)	Single PM [parallel monitor position] monitoring both LAX Rwy 25UR and HHR Rwy 25 LOC (additional Rwy to monitor) (Operational Scenario) Additional workload (Human Factors)	ATIS ARSR, ASR-9 ASDE-X, AMASS ATIS, TCAS ARTS, STARS (Equipment) RADIOS, Frequency monitoring Additional Flight Deck Communication (Equipment, Procedures) NOTAMs AC/150-5200-28d Airfield Operations monitoring AT Controller intervention Operational supervision Pilot intervention Traffic Management/TMI 7110.65, SOP 7210.3, LOA, 8260.59 FAR Part 139 Daily Briefings NOTAMs, CRM FAR Part 91 FAR Part 135 (Procedures) Scanning, ATC Training (Procedures, Training)	Pilot Notifications SCT SOP- to include procedures for conducting this operation Radios, Frequency monitoring- Provided by Parallel monitor positions per SCT SOP LOA with HHR/SCT will be updated describing procedures for this operation (Procedures) Controller training Team Briefings/ETG training (Training)	Initial: 2D Residual: 2D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
9	HHR-02	Inability of PM to instantaneously give command instructions to a HHR arrival (Operational Scenario or Equipment)	No instantaneous two-way communication between PM 1 and pilot of HHR arrival (Equipment)	ARSR, ASR-9 ATIS, TCAS ARTS, STARS CA/MSAW (Equipment) RADIOS, Frequency monitoring Additional Flight Deck Communication (Equipment, Procedures) AT Controller intervention Operational supervision Pilot intervention Traffic Management/TMI 7110.65, SOP 7210.3, LOA, 8260.59 FAR Part 139 Daily Briefings FAR Part 91 FAR Part 135 (Procedures) Scanning, ATC Training (Procedures, Training)	SCT SOP to include PM- duties and procedures for concurrent operations SCT/HHR LOA to be updated describing HHR Local Control responsibilities for this operation (Procedures)	Initial: 4D Residual: 4D

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
9	HHR-03	Conducting simultaneous approach operations to an airport with a closed tower (Operational Scenario)	Contract Control Tower hours (Operational Scenario)	ARSR, ASR-9 ATIS, TCAS ARTS, STARS CA/MSAW (Equipment) RADIOS, Frequency monitoring Additional Flight Deck Communication (Equipment, Procedures) Published noise abatement procedures at HHR reduce traffic SCT SOP to include procedures for this operation HHR/SCT LOA to be updated describing procedures for this operation AT Controller intervention Operational supervision Pilot intervention Traffic Management/TMI 7110.65, SOP 7210.3, LOA, 8260.59 FAR Part 139 Daily Briefings NOTAMS, CRM FAR Part 91 FAR Part 135 (Procedures) Scanning, ATC Training (Procedures, Training)	AOV requirement that HHR FCT be open (Procedures)	Initial: 4D Residual: Hazard Eliminated

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
9	HHR-04	HHR Localizer failure without timely notification to ATC (Equipment)	HHR localizer not monitored by ATC after tower is closed (Operational Scenario)	ARSR, ASR-9 ATIS, TCAS ARTS, STARS CA/MSAW (Equipment) RADIOS, Frequency monitoring Additional Flight Deck Communication (Equipment, Procedures) 7210.3, LOA, 8260.59 NOTAMs, CRM 6000.15E, NEMACS FAR Part 91 FAR Part 135 Daily Briefings SOC is monitoring HHR Localizer Flight check study attached to support area observation of radar coverage AT Controller intervention Operational supervision Pilot intervention 7110.65, SOP (Procedures) Scanning, ATC Training (Procedures, Training)	AOV requirement that HHR FCT be open (Procedures)	Initial: 5D Residual: Hazard Eliminated

Table B-1. Other hazards for changes to FAA order 7110.65 sections 5-5-4 and 5-9-7 (continued)

Ref.	Hazard ID	Hazard Description (Type)	Causes (Type)	Existing Controls (Type)	Recommended Safety Requirements (Type)	Risk
9	HHR-05	Lack of positive control of VFR aircraft operating on or near the HHR final (Operational Scenario)	HHR LOC RNWY 25 final approach course not contained in Class Bravo airspace Conflicting 'ownership' of the HHR final (HHR Tower/PM/VFR Pilot) (Operational Scenario)	ARSR, ASR-9 ATIS, TCAS ARTS, STARS CA/MSAW (Equipment) RADIOS, Frequency monitoring Additional Flight Deck Communication (Equipment, Procedures) 7210.3, LOA, 8260.59 FAR Part 139 Daily Briefings AT Controller intervention Operational supervision Pilot intervention 7110.65, SOP FAR Part 91 (Procedures) Scanning, ATC Training (Procedures, Training)	SCT SOP to include procedures for Tower open/Closed operations SCT/HHR LOA to be updated describing procedures for this operation (Procedures)	Initial: 4D Residual: 4D
9	HHR-06	Inability to provide radar monitoring in accordance with 7110.65, paragraph 5-9-7 c 3 (c) (Operational Scenario)	Lack of Radar coverage for HHR arrival below 600 feet (Equipment)	ATIS, TCAS (Equipment) RADIOS, Frequency monitoring Additional Flight Deck Communication (Equipment, Procedures) 7110.65, para 5-9-7 c 3 (a), (b) and (c) Flight check Study to support radar coverage to Minimum Descent Altitude 7110.65, SOP FAR Part 91 FAR Part 135 (Procedures)	SCT SOP to be updated to include 5-9-7 3(C) - terminate radar monitoring 1 mile or less from the threshold SCT/HHR LOA to be updated requiring the pilots to report approach lights or runway in sight at or before LAX 6.2 NM DME fix (1mile final) or the approach clearance will be cancelled by HHR ATCR (Procedures)	Initial: 2D Residual: 2E