Controller Safety Benefits in Low Volume Tower Operations: A Human Factors-Safety Assessment

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14. ABSTRACT
This report details the methodology and findings of the assessment of controller safety benefits in low volume tower operations. The study examines safety reports from low volume towers to identify services controllers are providing to ensure safe operatoins and examines safety reports from non-towered airports to identify opportunities where controllers could potentially provide a safety benefit. The study resulted in the identification of three low volume towered airport risk-benefit pathways and five non-towered airport risk-benefit pathways.

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EXECUTIVE SUMMARY

Introduction

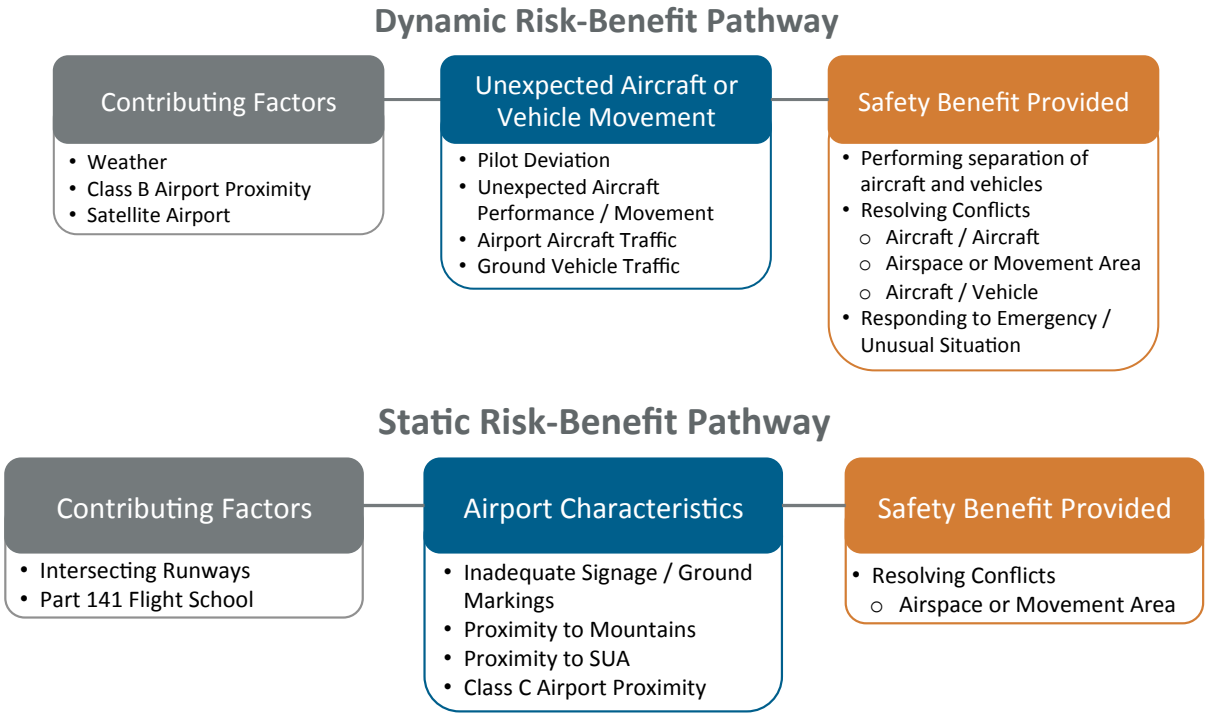
This report outlines the results and conclusions from a systematic assessment of the controller benefits present in NAS operations. The study included three primary activities to assess controller safety benefits. First, an assessment of tower controller tasks was completed to identify safety-critical controller tasks performed by tower controllers. Second, an assessment of the operational impact of these safety-critical tasks was conducted for towers in Class D airspace. Finally, an evaluation of safety events occurring in non-towered airports was conducted to identify the missing controller tasks that could have potentially prevented the adverse event or aided in the recovery from the adverse event.

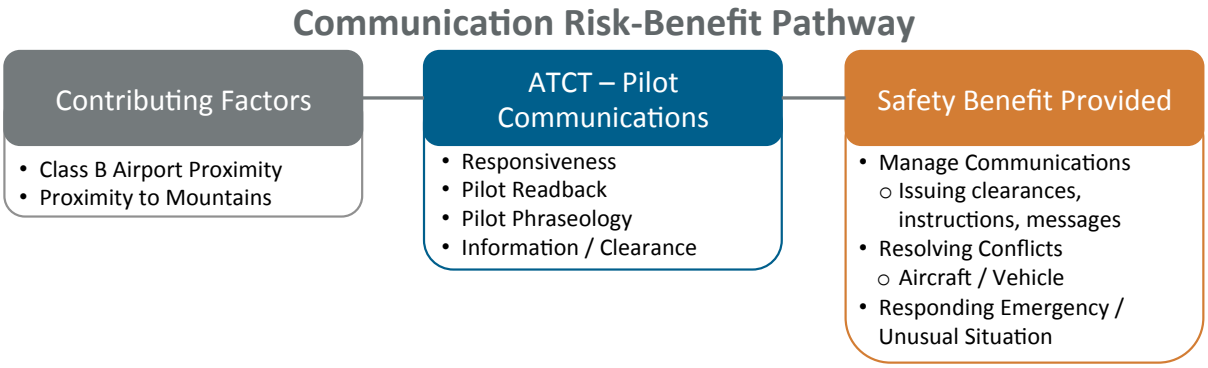
Safety-Critical Controller Tasks

An initial assessment of 400 different tower controller tasks identified 130 safety-critical controller tasks with an additional 31 tasks that support the safety-critical tasks. The safety-critical tasks were then used to assess the actual or potential controller safety benefits present in towered and non-towered operations. A full listing of safety-critical tasks is included in Appendix D.

Controller Provided Safety Benefits in Towered Operations in Class D Airspace

An analysis of 175 safety events occurring at or around towered airports in class D airspace were examined to quantify the safety benefits provided by controllers. Three significant risk-benefit pathways shown below identify the connection between factors contributing to the safety event (gray), the adverse safety event (blue), and the safety benefit provided by the controller to detect and recover from that event (orange).





Potential Controller Safety Benefits in Non-Towered Airport Operations

An analysis of 73 safety events occurring at or around non-towered airports was completed to determine the potential safety-critical controller tasks that could have been provided by a tower controller. The assessment yielded 5 statistically significant risk-benefit pathways showing the controller tasks that could have reduced the severity or consequences of the reported events. Two significant pathways were associated with preventing adverse events through the use of visual separation tasks and the issuance of takeoff instructions. Two additional pathways were identified related to controller tasks associated with recovering from adverse events through conflict resolution instructions and response to emergencies or unusual operations. A final potential controller benefit was identified for controller tasks associated with managing specific airport characteristics such as intersecting runways, proximity to Class B airports, and proximity to special use airspace. Each pathway quantifies the relationship between risk factors and potential controller benefits to identify the controller tasks that could have provided the largest safety benefit.

Conclusion

A significant portion of the tasks completed by air traffic controllers directly contribute to the safe operations of both commercial and general aviation operations. By systematically analyzing these tasks and operational events, the actual safety benefits present in NAS operations can be identified and measured. The results could serve to identify particular types of operations where a controller could provide the largest potential safety benefit.

LIST OF ACRONYMS

Acronym	Definition
AIM	Aeronautical Information Manual
AIR	American Institute for Research
AirTracs	Air Traffic Analysis and Classification System
ANG-C1	Human Factors Division
ANSP	Air Navigation Service Provider
APO	Office of Policy and Plans
ASRS	Aviation Safety Reporting System
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATIS	Automatic Terminal Information Service
ATP	Airline Transport Pilot
ATSAP	Air Traffic Safety Action Program
AVP	Office of Accident Investigation and Prevention
CFI	Certified Flight Instructor
CFIT	Controlled Flight Into Terrain
DoD	Department of Defense
EMSAW	En Route MSAW
EOVM	Emergency Obstruction Video Maps
FAA	Federal Aviation Administration
FOD	Foreign Object Debris
HFACS	Human Factors Analysis and Classification System

Acronym	Definition
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LAAS	Local Area Augmentation System
LAHSO	Land And Hold Short Operations
MSAW	Minimum Safe Altitude Warning
NAS	National Airspace System
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
SAA	Special Activity Airspace
SIA	Status Information Area
SJA	Strategic Job Analysis
SME	Subject Matter Expert
SRM	Safety Risk Management
SUA	Special Use Airspace
TAF	Terminal Area Forecast
TFR	Temporary Flight Restrictions
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control Facility
VATS	Visual Air Traffic Services
VFR	Visual Flight Rules

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INTRODUCTION

Air Traffic Control Towers (ATCT) and the controllers that staff them provide both efficiency and safety services to the aviation industry. The primary responsibility of an ATCT controller is to prevent collisions between aircraft and other hazards (e.g., terrain, ground vehicles) on the airport surface and in the immediate vicinity of the airport (FAA, 2012). Set in 1990, the Office of Policy and Plans (APO) developed criteria for the establishment and discontinuance of ATCT (FAA-APO-90-7) (FAA, 1990). However operations in the NAS have and are continuing to transition to support NextGen initiatives and other enhancements to the NAS. The FAA's APO is reviewing and potentially updating the cost, safety benefit, and efficiency benefit criteria outlined in the 1990 policy for ATCT establishment with the focus of the review on those low volume tower operations, such as airports in Class Delta (Class D) airspace. In examining the safety benefit of ATCT controllers, the safety service being provided by tower controllers at towers with larger operations, such as the Core 30 airports, greatly exceeds the costs of establishing those towers. Controllers at those larger operation towers are necessary to efficiently and safely manage air traffic. However, as the number of operations at a tower decreases the costs of operating the tower may begin to outweigh the benefits.

Initiating the evaluation of the safety benefits, the FAA-APO-90-7, the FAA's Office of Accident Investigation and Prevention (AVP) conducted an evaluation of airports in Class D airspace (FAA, 2013). The AVP evaluation incorporated the first two steps of the safety risk management (SRM) process by first analyzing the system and then identifying hazards. The presence or absence of those hazards was categorized for the 373 towered airports in Class D airspace. The hazards identified by the panel were hazards linked to three high risks: mid-air collisions, ground collisions resulting from runway incursions, and controlled flight into terrain. The AVP analysis of the Class D airports serves as a foundation for identifying hazardous airport characteristics tower controllers can mitigate.

PURPOSE

The AVP evaluation of Class D airports identifies hazards and classifies those hazards for towered airports in Class D airspace. The impact those airport characteristics have on operations and controller performance has yet to be fully examined. The purpose of this study is to assess the operational safety benefit being provided by tower controllers in Class D airspace and to determine the potential safety benefit that a controller could have provided during safety events in non-towered operations. To support the review of the FAA-APO-90-7, this study focused on three objectives for visual air traffic services (VATS):

1. Identification and description of safety-critical tasks performed by tower controllers.
2. Assessment of the operational impact of safety-critical tasks being performed by controllers in towers in Class D airspace.
3. Evaluation of non-towered airport operations to determine the potential for operational safety gain and the potential impact of the safety gain.

METHODOLOGY

In order to identify human factors – safety benefits and opportunities in operations, the activities, sub-activities, and tasks conducted by tower controllers were assessed to identify those tasks that are considered safety-critical. Those tasks were then examined using operational data to identify visual air traffic safety services being provided by tower controllers in low volume operations towers and to identify the safety services potential at non-towered airports.

SAFETY – CRITICAL TASK IDENTIFICATION

The FAA's Human Factors Division (ANG-C1) funded a project by the American Institute for Research (AIR) to examine the job of the air traffic controller by conducting a strategic job analysis (SJA) for each domain. The resulting SJA (AIR, 2011) identifies the work the tower controller performs to successfully complete the job. The resulting SJA describes the work a tower controller preforms to successfully complete the job in the hierarchical form of activities, sub-activities, and tasks.

- Task: "Very specific work activities performed for a specific purpose"
- Sub-Activity: "Collections of tasks that have a common objective"
- Activity: "Groups of sub-activities and their associated tasks"

The tasks included in the SJA incorporate tasks that are necessary for safety and efficiency. For example, the tasks associated with a controller responding to a flow constraint help to improve flow and efficiency but do not necessarily directly impact safety.

An ATCT subject matter expert (SME) and a pilot SME reviewed the SJA, and in particular, the tasks to identify which of those tasks provide a safety-critical benefit to either the controller, pilot, or airspace / airport. Safety-critical tasks are those tasks that directly impact the safety of the National Airspace System (NAS) and those operating in the NAS. Additionally, those tasks that contribute to safety were also identified. Those safety-contributing tasks were tasks that initiate a safety-critical task. For example, a controller must first scan the runway in order to identify a runway incursion.

ASSESSMENT OF VATS OPERATIONS AT TOWERED AIRPORTS IN CLASS D AIRSPACE

For the safety benefits assessment of VATS, a sample of FAA towered airports in Class D airspace were identified utilizing the AVP evaluation (FAA, 2013), and operations network (Ops Net) data from calendar year 2011 was collected for each airport. From the FAA towered Class D airports, a sample of 35 low volume airports were identified and correlated with the AVP evaluation of airport characteristic information and attributes. For the complete listing of the 35 towered airports included in this analysis, see Appendix A.

Data Collection and Filtering

The data utilized for this assessment was gathered from the FAA's Air Traffic Safety Action Program (ATSAP). ATSAP is a voluntary, non-punitive reporting system for air traffic controllers. For this assessment, ATSAP reports submitted by controllers at the sample airports for the calendar years of 2011, 2012, and 2013 time period were queried, resulting in 792 reports and safety event narratives. The focus of the ATSAP program is to provide the air traffic community an outlet for reporting a safety event that might otherwise have gone unknown. The purpose of this analysis is to examine the safety benefits controllers provide in the control tower environment. The 792 ATSAP reports were filtered to identify those reports describing a safety event where the controller provided a safety benefit. The question examined in the filtering exercise was, "Did the controller provide a service that reduced the severity or consequences of the safety event described in the report?" Each of the 792 ATSAP reports were examined with the question by at least two human factors SMEs, resulting in 175 ATSAP reports being identified as describing a safety event where a controller provided a safety benefit.

Air Traffic Analysis and Classification System

In order to assess the safety benefit being provided by controllers in FAA staffed towers in Class D airspace, a comprehensive methodology for examining human factors issues in safety reports was needed. The Air Traffic Analysis and Classification System (AirTracs) systemically and thoroughly examines the impact of human performance in air traffic safety events. Two air traffic controller human factors taxonomies, Human Factors Analysis and Classification System (HFACS) and HERA-JANUS, were merged to develop AirTracs. This combination allowed for the strengths of each taxonomy to be incorporated, while the individual weaknesses could be addressed (Berry, Sawyer, & Austrian, 2012). The framework of the AirTracs causal factor model was based on the Department of Defense (DoD) HFACS model (DoD, 2005), and the detailed causal factor categories incorporated factors from HERA-JANUS (Isaac et al., 2003). The AirTracs framework promotes the identification of human factors causal trends by allowing factors from the immediate operator context to agency-wide influences to be traced for individual events and for a comprehensive analysis to be executed. The AirTracs causal factor model can be found in Figure 1, and the details of the causal factors can be found in Table 1.

The AirTracs model follows a tiered approach. The first tier, Operator Acts, addresses those causal factors most closely linked to the actual safety event and describes the actions or inactions of the operator. Operator Acts causal factors are classified as sensory acts, decision acts, execution acts, or willful violations. The second tier, Operating Context, describes the immediate environment associated with the operator and the safety event. Operating Context causal factors are classified as controller workspace (physical and technological environment), controller readiness (cognitive and physiological factors and knowledge/experience), and NAS factors (airport conditions, airspace conditions, aircraft actions, and coordination and communication). The third tier, Facility Influences, describes the factors related to the actions or inactions of individuals at an ATC facility that have the ability to impact the whole facility or multiple individuals at a facility. Facility Influences causal factors are classified as supervisory planning, supervisory operations, and traffic

management unit (TMU). The fourth tier, Agency Influences, examines those factors related to the actions or inactions of the Agency and is classified as resource management, Agency climate, and operational process. The fifth tier, Outside Influences, describes the impact of other actors and Agencies outside of the FAA and is classified as airline influences, military influences, contract tower influences, other Air Navigation Service Provider (ANSP) influences, and any other outside influences.

Table 1: AirTracs Causal Factor Descriptions

Operator Actions
Sensory Acts: Occur when a controller's sensory input is degraded and a plan of action is determined based upon faulty information. Sensory benefits occur when a controller's sensory input and comprehension aids in the safe outcome or recovery from an event.
Categories: Auditory Perception, Visual Perception, Temporal Perception
Decision Acts: Occur when a controller's behaviors or actions proceed as intended yet the chosen plan proves inadequate to achieve the desired end-state and results in an unsafe situation. For decision acts, the controller has adequate sensory information, but an error occurs in the development of a plan of action to the sensory information. Decision benefits occur when a controller's development of a plan of action aids in the safe outcome or recovery from an event.
Categories: Alert Comprehension, Knowledge/Planning, Prioritization, Tool/Equipment Use
Execution Acts: Occur when a controller's execution of a routine, highly practiced task relating to procedure, training or proficiency result in an unsafe a situation. For execution acts, the controller has adequate sensory information and has developed a correct plan, but an error occurs in the performance of the plan. Execution benefits occur when a controller's execution of tasks aids in the safe outcome or recovery from an event.
Categories: Controller Technique, Memory/Attention, Communication Act, Inadvertent Operation
Willful Violation: The actions of the operators that represent a willful and knowing disregard for the rules and regulations. Willful Violations are deliberate.
Categories: Willful Violation
Operator Context
Physical Environment: The operational and ambient environment of the controller's immediate workspace.
Categories: Workstation/Work Area, Lighting, Noise Interference, Vision Restricted
Technological Environment: The workspace automation factors include a variety of design and automation issues, including the design of equipment and controls, display/interface characteristics, checklist layouts, task factors and automation.
Categories: Communication Equipment, Display/Interface, Software/Automation, Warnings/Alarms, Data Block, Flight Progress Strips
Airport Conditions: The environmental and design conditions of the airport involved in the event.
Categories: Combined Positions, Ground Vehicle Traffic, Aircraft Traffic, Airport Weather, Signage/Lighting/Ground Markings, Construction, Layout/Design
Airspace Conditions: The physical or design conditions of the airspace involved.
Categories: Combined Sectors, Combined Positions, Sector Traffic, Sector Weather/Turbulence, Sector Design
Aircraft Actions: The actions or inactions of the aircraft involved in the event that lead to an unsafe situation.
Categories: Deviation, Unexpected Aircraft Performance, Aircraft Equipment/System Operations, Responding to Abnormal Situation, Go Around, Flight Planning, TCAS RA Response

Communication: The teamwork factors of coordination and communication involved with the preparation and execution of a plan that result in an unsafe situation.
Categories: Controller-Cockpit Communication, Controller-Controller Communication
Cognitive and Physiological Factors: Cognitive or mental conditions and the physiological or physical factors that result in an unsafe situation.
Categories: Attention, Workload, Complacency/Vigilance, Automation Reliance, Expectation Bias, Fatigue
Knowledge/Experience: The experience or knowledge level a controller has for a task, procedure, or policy that result in an unsafe situation.
Categories: On-the-Job Training/Developmental, Trainer Intervention, Low Experience CPC, Unfamiliar Task/Procedure
Facility Influence
Supervisory Planning/Preparation: The planning and preparation of operations conducted by facility management that result in an unsafe situation.
Categories: Facility Procedure, Staffing, Equipment, Training
Supervisory Operations: The day-to-day operations and tasks conducted by facility management that result in an unsafe situation.
Categories: Sector Combination, Position Combination, Controller Assignment, Oversight/Assistance, Sector/Airport Configuration, Supervisory Coordination
Traffic Management Unit: The operations of the traffic management unit and their impact on the controller that result in an unsafe situation.
Categories: Weather Response, Special Use Airspace (SUA), Traffic Management Initiatives, Traffic Regulation/Delivery
Agency Influence
Resource Management: The organizational-level decision-making regarding the allocation and maintenance of organizational assets that result in an unsafe situation.
Categories: Equipment/Facility Resources, Human Resources
Agency Climate: The organizational variables including environment, structure, policies, and culture that result in an unsafe situation.
Categories: Culture, Policy
Operational Process: The organizational process, including operations, procedures, operational risk management and oversight that result in an unsafe situation.
Categories: Procedures/Operations, Oversight, Response to Event/Report
Outside Influence
Airline Influences: The actions or inactions of the airlines impacting NAS operations.
Military Influences: The actions or inactions of the military impacting NAS operations.
Contract Tower Influences: The actions or inactions of contract towers impacting NAS operations.
Other ANSP Influences: The actions or inactions of other ANSP impacting NAS operations.
Other Influences: The actions or inactions of other organizations external to the agency.

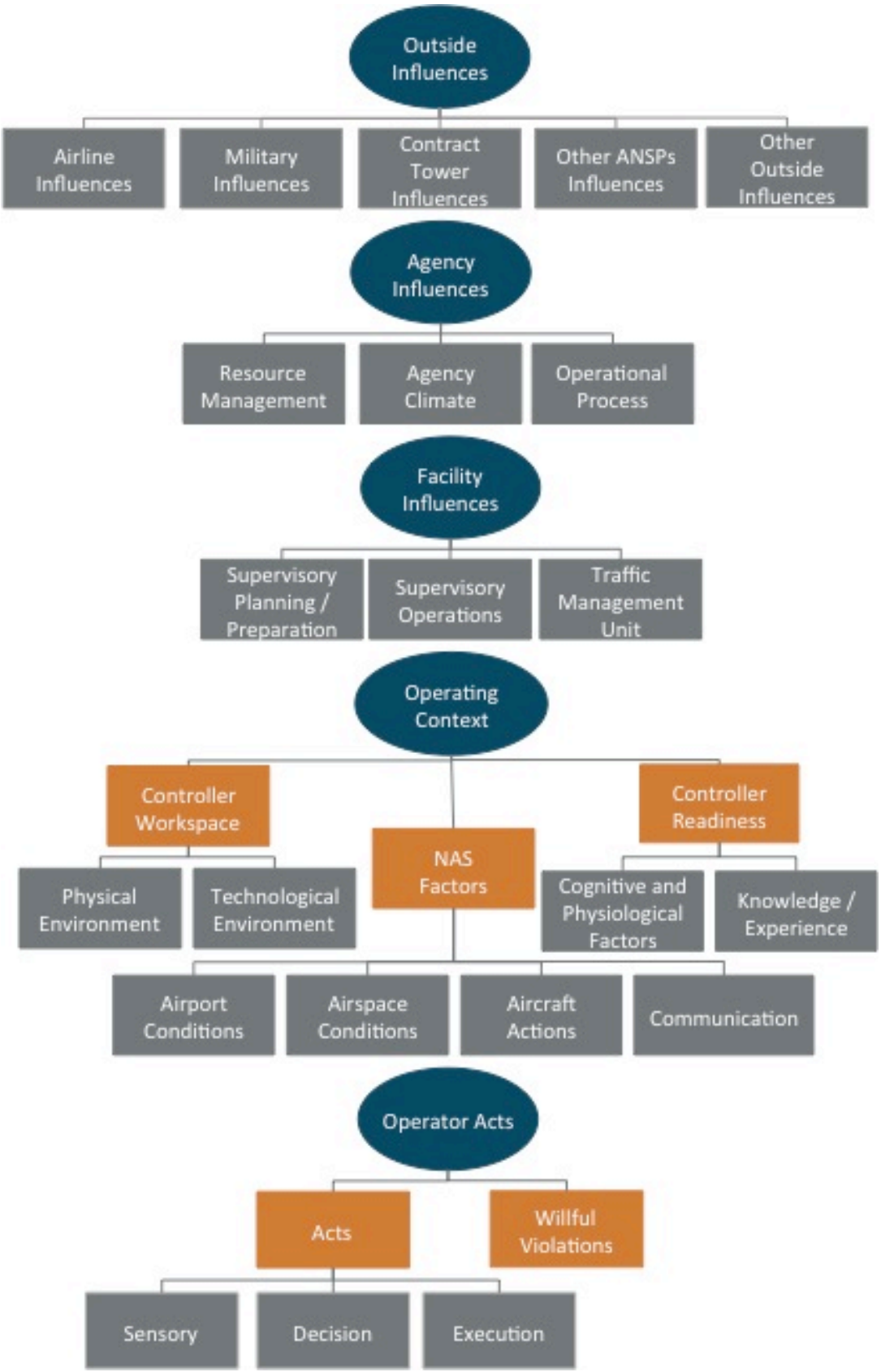

Figure 1: Air Traffic Analysis and Classification System – AirTracs

Application of AirTracs and the Safety – Critical Task Analysis

For safety events classified with the AirTracs taxonomy (Appendix B), the presence or absence of each AirTracs causal factor at all tiers was examined. The AirTracs causal factors are not mutually exclusive, and safety event classifications may include causal factors from all five tiers. For example, an individual safety event can include an execution act, a sensory act, a cognitive and physiological factor, supervisory operations, and an operational process factor. When a factor in Table 1 is identified, the classification of the factor is determined as adverse, neutral, or positive. Adverse factors are then classified as causal or contributory. The definitions of each classification type can be found in Table 2.

Table 2: Factor Classification

Classification		Factor Definition
Adverse	*Causal*	An immediate/direct factor that identifies an active error or failure of critical components of equipment, systems, or human error. *Causative: If "A" occurs, then "B" will occur.*
	Contributory	An underlying/root factor that identifies latent errors or failures related to human performance, operating environment, task procedures, training, supervision, or policy that influence the presence of causal factors. *Probabilistic: If "A" occurs, then the probability of "B" occurring increases.*
Neutral	*Observed*	A factor that is present but the associated impact of the factor on the safety event has not been proven. It is recorded to note its potential influence on the event or actors involved and to be incorporated into trend analysis.
Beneficial	*Positive*	A factor that positively contributed to the safety of an event. This can include factors or actions that contributed to the detection of, or recovery from, an adverse outcome.

While classifying the 175 ATSAP reports, 69 of the reports were removed due to lack of information. The resulting 106 ATSAP reports were classified with AirTracs utilizing the consensus method, which requires a consensus or agreement on the factors contributing to the incident by a panel. The panel members included human factors representatives, air traffic controller SMEs, and cockpit experts. Each report was evaluated across all levels of the AirTracs framework, and the presence or absence of each AirTracs causal factor was recorded. For those factors designated as a positive factor, the factors further classified with SJA safety-critical tasks being provided. Finally, the severity of each safety event and the safety benefit outcome were classified. The severity was classified as one of the following: no safety effect, near runway incursion, runway incursion, near airspace violation, airspace violation, near conflict, or conflict.

Table 3: Safety Benefit Outcome Categories

Outcome Category	Description
A	Controller issued traffic advisory or alerts to provide separation or sequencing
B	Controller cleared / prevented a runway incursion – no traffic conflict
C	Controller cleared / prevented a runway incursion – traffic conflict / go-around
D	Controller assisted the pilot in avoiding closed runway, shortened runway, construction, surface hazard, TFRs, or other NOTAM issues
E	Controller assisted in an aircraft emergency / unusual situation
F	Controller corrected an aircraft's altitude or course
G	Controller provided safety-related weather information
H	Controller prevented / resolved airspace violation

Statistical Methods

In addition to the traditional frequency assessment of factors, this assessment incorporates examining the relationships among the adverse and positive factors and tasks. To identify risk pathways and factor relationships, associations among factors and tasks were measured. Starting at the highest AirTracs tier, Outside Influences, the relationship among each factor at the higher tier and the various factors and tasks at lower tiers was examined using a Pearson's chi-square test to measure the statistical strength of the association. In the instances where the assumptions of the Pearson's chi-square test were not met, a Fisher's exact test was conducted (Sheskin, 2011). If the relationship resulted in a significant association being identified through the Pearson's chi-square test or Fisher's exact test ($p<0.05$), the odds ratio value was calculated for that particular association (Sheskin, 2011).

Assessment of Potential VATS Operations at Non-Towered Airports

In addition to assessing the actual safety benefit achieved at FAA staffed tower airports, the potential for safety opportunities at non-towered airports was examined. A sample of non-towered airports was selected through identifying analogous traffic level and type to the FAA staffed towered airport sample set using Ops Net data and Terminal Area Forecast (TAF) data. The non-towered airports sample set can be found in Appendix A, which also details the airport characteristic information and attributes.

Data Collection and Filtering

The data utilized for this assessment was gathered from the Aviation Safety Reporting System (ASRS), which is a voluntary, non-punitive reporting system for the aviation community as a whole. For this assessment, ASRS reports submitted by pilots at the sample non-towered airports from the calendar years 2002-2013 were queried, resulting in 73 ASRS reports and safety event narratives. Similar to the ATSAP analysis, the ASRS reports were filtered to identify those reports describing a safety event where the controller could potentially provide safety benefit if present. The question examined in the filtering exercise was, "Can a controller provide a service that would reduce the

severity or consequences of the safety event described in the report?" Each of the 73 ASRS reports were examined with the question by at least two human factors SMEs, resulting in 44 ASRS reports being identified as describing a safety event where a controller could potentially provide a safety benefit.

Application of Modified AirTracs and the Safety – Critical Task Analysis

In order to assess the safety benefit opportunities being missed in the non-towered airport safety events, the reports were classified similarly to the towered airport assessment but with a Modified AirTracs (Appendix C). The modified AirTracs included two additional Operator Actions categories – Aircraft Errors and Potential Controller Actions – and can be found in Table 4. The modified AirTracs also included other changes at the Operator Context level. A factor in the Communications category was included to capture Cockpit – Cockpit Communications. Finally, similar statistical methods were applied to the resulting ASRS event assessment.

Table 4: Modified AirTracs

Operator Actions
Aircraft Errors: Occur when the actions of a Flight Crew member affect the outcome or recovery from an event.
Categories: Incomplete Scan of Aircraft Location, Lined up on Unexpected Runway (airborne), Gear-up Landing, Unexpected Turn, Improper Sequence, Failed to Execute Missed Approach, Pilot Technique-Braking, Other
Potential Controller Action: A service that could have been provided by a controller that would have aided in the safe outcome or recovery from an event.
Categories: Potential Controller Action

Additionally, the safety reports from the non-towered airport sample set were also examined with the SJA assessment. For each Potential Controller Action factor, the factor was also categorized with the SJA Safety-Critical sub-activity to identify first how an ATCT controller would have prevented the safety event and then how an ATCT controller would have assisted in the recovery from the safety event.

National Transportation Safety Board (NTSB) Safety Reports

As a follow up study, AVP (FAA, 2014) conducted a review of NTSB fatal events and identified 24 events in which a controller "could have made a difference." To expand on this assessment, a group of human factors, cockpit, and ATC SMEs reviewed the 24 NTSB reports to identify causal factors and hazards and to identify prevention and recovery safety-critical tasks that could be performed by a controller to impact the event if one was present.

FINDINGS

Findings will be presented and discussed in the sections below. The key findings from the towered airports and non-towered airports analyses will be presented. Full, detailed results for both assessments are presented in appendices.

SAFETY-CRITICAL TASKS ANALYSIS

Figure 2 displays the findings for the safety-critical tasks analysis. The original SJA included 11 activities with 400 ATCT tasks. After a review of the 400 ATCT tasks, 161 of the ATCT tasks were found to directly impact safety. Those 161 tasks were then categorized as "safety-critical" or "contributes to safety." Safety-critical tasks are those tasks that directly impact the safety of the NAS and those operating in the NAS. Additionally, those tasks that contribute to safety were also identified. Those safety-contributing tasks were tasks that initiate a safety-critical task. For example, a controller must first scan the runway in order to identify a runway incursion. Thirty-one of the ATCT safety tasks were identified as "contributes to safety," and 130 of the ATCT safety tasks were identified as "safety-critical."

Figure 2: Safety-Critical Tasks Analysis Findings

Tables 5 and 6 show a sample ATCT task that contributes to safety and a sample ATCT task that is safety critical, respectively. All 161 ATCT tasks having a direct safety impact are listed and described in Appendix D with the full 400 ATCT task assessment to be provided in supplemental material.

Table 5: Contributes to Safety Sample Task

ATCT Task	T11: Scan control environment to gather information about aircraft and vehicles
Safety Criticality	Contributes to Safety
ATC Safety Benefit	Scanning of the control environment is how controllers verify that aircraft and ground vehicles are conforming to their stated intentions and/or control instructions. Identifying non-conformance in a timely fashion can prevent runway incursions, airspace violations, losses of separation, and potential or possible emergency situations.
Cockpit Safety Benefit	This task is an essential component of preventing collisions, preventing accidents, and assisting with emergency situations. ATC serves as redundant set of eyes and ears with an often better perspective than the cockpit.
Example	Identify that aircraft gear is not down on short final. Observe that aircraft initiate assigned turn in the correct direction to ensure separation. Observe a vehicle enter an active runway without a clearance.

Table 6: Safety-Critical Sample Task

ATCT Task	T175: Issue advisory or traffic alert as appropriate
Safety Criticality	Critical to Safety
ATC Safety Benefit	The controller issues safety alerts to pilots to improve the pilot's or vehicle driver's situational awareness of the surrounding environment and to give the reasoning behind the control instruction to further ensure compliance to the instruction.
Cockpit Safety Benefit	Improves pilot's situational awareness and gives urgency to instruction. Additionally assists pilot in developing his/her own mental model to further understand how to avoid the violator.
Example	Issue an advisory to the vehicle (e.g., "Stop, traffic touching down on the runway"). Issue an advisory to the aircraft (e.g., canceled takeoff clearance due to vehicle unexpectedly entering runway)

Human Factors-Safety Risk-Benefit Pathways for Sample Set of FAA Staffed Towered Airports in Class D Airspace

When examining the safety benefits tower controllers provide at the sample set of FAA staffed towered airports in Class D airspace, the three following human factors safety-benefit pathways emerge and will be discussed in the following sections:

- Dynamic Risk-Benefit Pathway
- Static Risk-Benefit Pathway
- Communication Risk-Benefit Pathway

The human factors safety-benefit pathways represent key associations among AirTracs factors, safety-critical tasks, and airport characteristics. The relationships underlying the benefit pathways include the key risk factors and safety benefits and their associations found significant with the statistical tests described in the methodology section of the report. The overall AirTracs and SJA safety-critical task application results from the towered airport analysis can be found in Appendix E.

Dynamic Risk-Benefit Pathway for Class D Towered Airports

The first human factors-safety risk-benefit pathway incorporates how a controller at a Class D towered airport provided a safety-benefit service to mitigate a dynamic risk and can be found in Figure 3.

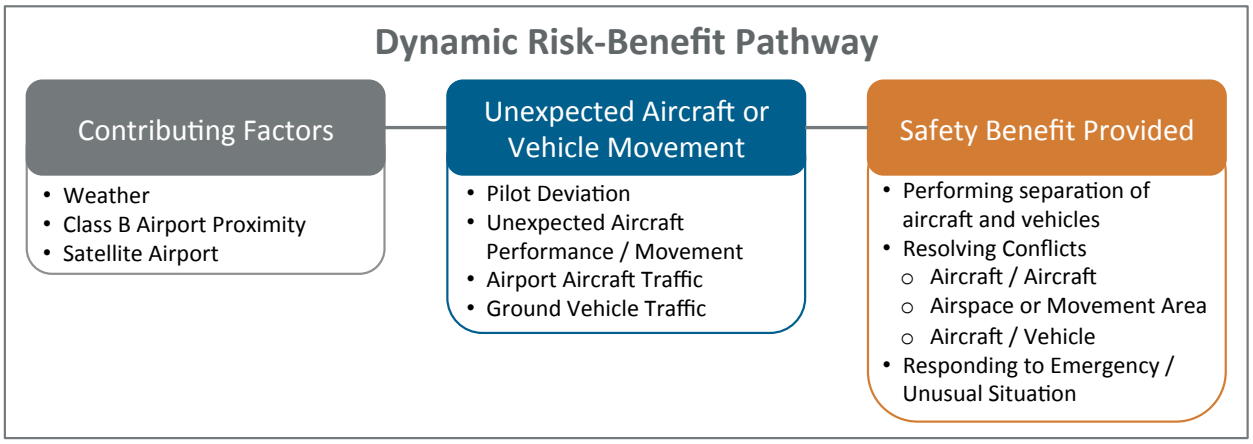

Figure 3: Dynamic Risk-Benefit Pathway

The central blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk to operations in the ATSAP reports. For this pathway, those factors were dynamic in nature since they were a result of human actions and are not consistently present at all airports in every situation. Those dynamic risk factors were found to be pilot deviations, unexpected aircraft performance / movement, airport surface aircraft traffic, and ground vehicle traffic with Table 7 showing the level of classification for each risk factor. The values in Table 7 can be interpreted in the following way: in 62.26% of the ATSAP reports classified there was a pilot deviation. In most cases, risk factors represent active pilot or driver errors or failures, and it is necessary to examine

the latent factors associated with those risk factors to better understand why those risk factors may occur.

Table 7: Risk Factor Classification Level – Dynamic Risk–Benefit Pathway

Risk Factor	Percentage of Classified Reports
Pilot Deviation	62.26% of ATSAP Reports
Unexpected Aircraft Performance / Movement	25.47% of ATSAP Reports
Airport Surface Aircraft Traffic	10.38% of ATSAP Reports
Ground Vehicle Traffic	6.60% of ATSAP Reports

The left gray box in the risk-benefit pathway graphic depicts the contributing factors associated with the risk factors. The contributing factors represent a combination of the airport characteristics and attributes from the AVP study for the sample set of airports (e.g., Class B Airport Proximity) and contributing factors from the application of AirTracs (e.g., weather). Those contributing factors found to be associated with the dynamic risk factors were weather, Class B airport proximity, and satellite airport with Table 8 showing the level of classification for each contributing factor. The values in Table 8 are represented in one of two manners: 1) For airport characteristics, 34.29% of the sampled towered airports are in proximity to a Class B airport; 2) For AirTracs factors, in 7.55% of the ATSAP reports classified, weather was a contributing factor.

Table 8: Contributing Factor Classification Level – Dynamic Risk–Benefit Pathway

Contributing Factor	Percentage of Classified Reports or Airports
Satellite Airports	42.86% of the Sampled Towered Airports
Class B Airport Proximity	34.29% of the Sampled Towered Airports
Weather	7.55% of ATSAP Reports

In order for the contributing factor to be included in the pathway, at least one of the contributing factors had to have a statistical association with at least one of the risk factors. Table 9 depicts the associations and their odds ratios. For those pairings with odds ratios, the pairing was first found to be statistically significant via the Pearson's Chi Square test or Fisher's Exact test ($p < 0.05$). Upon being found significant, the odds ratio for the pairing was determined. The odds ratio can be interpreted in the following way: when a report was found to include weather as a contributing factor, the odds of the report also including unexpected aircraft performance / movement were 5.758 times greater than those reports that did not indicate weather as a factor.

Table 9: Contributing Factors – Risk Factors Associations Odds Ratios – Dynamic Risk–Benefit Pathway

	Risk Factors	
Contributing Factors	Pilot Deviation	Unexpected Aircraft Performance / Movement
Satellite Airports	2.285	2.526
Class B Airport Proximity		2.526
Weather		5.758

The right orange box in the risk-benefit pathway graphic depicts the safety benefits being provided by a controller through safety-critical tasks. These safety-critical tasks depict how a controller identified, responded to, and recovered from the dynamic risks. For the dynamic risk-benefit pathway, the safety benefits being provided by tower controllers are performing separation of aircraft and vehicles, resolving conflicts, and responding to emergencies / unusual situations with Table 10 showing the level of classification for each benefit. The values in Table 10 can be interpreted in the following way: in 37.74% of the ATSAP reports classified, a controller performed safety-critical tasks related to resolving aircraft to aircraft conflicts.

Table 10: Contributing Factor Classification Level – Dynamic Risk-Benefit Pathway

Benefit	Percentage of Reports
Resolving Conflicts – Airspace or Movement Area	40.57% of ATSAP Reports
Resolving Conflicts – Aircraft / Aircraft	37.74% of ATSAP Reports
Responding to Emergencies / Unusual Situations	17.92% of ATSAP Reports
Resolving Conflicts – Aircraft / Vehicle	12.26% of ATSAP Reports
Performing Separation of Aircraft and Vehicles	8.49 % of ATSAP Reports

In order for the safety benefit to be included in the pathway, at least one of the risk factors had to have a statically significant association with at least one of the safety benefits. Table 11 depicts the associations and their odds ratios. For those pairings with odds ratios, the pairing was first found to be statistically significant via the Pearson's Chi Square test or Fisher's Exact test ($p < 0.05$). Upon being found significant, the odds ratio for the pairing was determined. The odds ratio can be interpreted in the following way: when a report was found to include a pilot deviation as a risk factor, the odds of the report including the safety-benefit tasks associated with resolving aircraft to aircraft conflicts were 2.50 times greater than those reports not including a pilot deviation.

Table 11: Risk Factors Safety Benefit Associations Odds Ratios – Dynamic Risk-Benefit Pathway

	Risk Factor			
Safety Benefit	Pilot Deviation	Unexpected Aircraft Performance / Movement	Airport Surface Aircraft Traffic	Ground Vehicle Traffic
Performing Separation of Aircraft and Vehicles (S13)			5.56	
Resolving Conflicts (A5)	9.05	3.19		
Resolving Conflicts – Aircraft / Aircraft (S20)	2.50		21.67	
Resolving Conflicts – Airspace or Movement Area (S22)	5.66	3.08		
Resolving Conflicts – Aircraft / Vehicle (S23)				78.86
Responding to Emergencies / Unusual Situations (A11)	14.00	6.10		

Static Risk-Benefit Pathway for Class D Towered Airport

The second human factors-safety risk-benefit pathway incorporates how a controller at a Class D towered airport provided a safety-benefit service to mitigate a static risk and can be found in Figure 4.

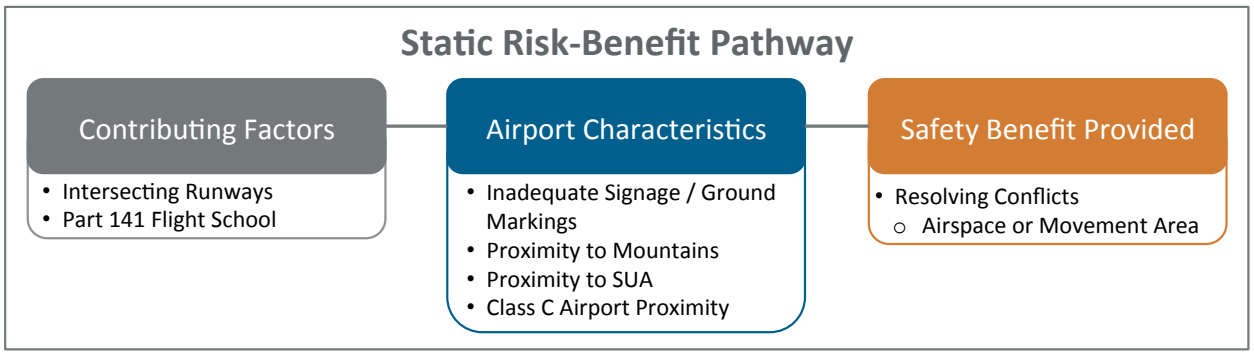

Figure 4: Static Risk-Benefit Pathway

The central blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk factor to operations in the ATSAP reports. For this pathway, those factors were static in nature in that they represent static airport characteristics. Those static risk factors were found to be signage / ground markings, proximity to mountains, proximity to SUA, and Class C airport proximity with Table 12 showing the level of classification for each risk factor.

Table 12: Risk Factor Classification Level – Static Risk-Benefit Pathway

Risk Factor	Percentage of Classified Reports or Airports
Proximity to Mountains	14.29% of the Sampled Towered Airports
Proximity to SUA	11.43% of the Sampled Towered Airports
Inadequate Signage / Ground Markings	8.49% of ATSAP Reports
Class C Airport Proximity	5.71% of the Sampled Towered Airports

The left gray box in the risk-benefit pathway graphic depicts the contributing factors associated with the risk factors. The contributing factors represent a combination of the airport characteristics and attributes from the AVP study for the sample set of airports (e.g., Class B Airport Proximity). For the static risk-benefit pathway, the contributing factors were found to be intersecting runways and proximity to a Part 141 flight school with Table 13 showing the level of classification for each contributing factor.

Table 13: Contributing Factors Classification Level – Static Risk-Benefit Pathway

Contributing Factor	Percentage of Classified Reports or Airports
Intersecting Runways	68.57% of the Sampled Towered Airports
Proximity to Part 141 Flight School	57.14% of the Sampled Towered Airports

In order for the contributing factor to be included in the pathway, at least one of the contributing factors had to have a statically significant association with at least one of the risk factors. Table 14 depicts the associations and their odds ratios between the contributing factors and risk factors for the static risk-benefit pathway. The signage / ground marking risk factor was found to be associated with intersecting runways contributing factor. When an airport has intersecting runways, the airport will have more signage / ground markings in order to protect and make pilots aware of the runways and their intersections. The signage / ground markings factor was most linked to events where pilots found the runway hold short bars to be unusually far from the runway, resulting in either a pilot passing the hold short bars entering an active runway or a pilot not fully passing the hold short bars when exiting a runway.

Table 14: Contributing Factors – Risk Factors Associations Odds Ratios – Static Risk-Benefit Pathway

	Risk Factors
Contributing Factors	Inadequate Signage / Ground Markings
Intersecting Runways	3.413
Proximity or Part 141 Flight School	9.244

The right orange box in the risk-benefit pathway graphic depicts the safety benefits being provided by a controller through safety-critical tasks. These safety-critical tasks depict how a controller

identified, responded to, and recovered from the static risks. For the static risk-benefit pathway, the safety benefit being provided by tower controllers are tasks related to resolving airspace or movement area conflicts, and Table 15 shows the level of classification for the benefit.

Table 15: Contributing Factor Classification Level – Static Risk-Benefit Pathway

Benefit	Percentage of Reports
Resolving Airspace or Movement Area Conflicts	40.57% of ATSAP Reports

The safety benefit is associated with all four risk factors present in the pathway, and Table 16 depicts the associations and their odds ratios.

Table 16: Risk Factors – Safety-Benefit Associations Odds Ratios – Static Risk – Benefit Pathway

	Risk Factor			
Safety Benefit	Inadequate Signage / Ground Markings	Proximity to Mountains	Proximity to SUA	Class C Airport Proximity
Resolving Airspace or Movement Area Conflicts (S22)	5.93	2.57	6.11	12.06

Communication Risk-Benefit Pathway for Class D Towered Airport

The final human factors-safety risk-benefit pathway incorporates how a controller at a Class D towered airport provided a safety-benefit service to mitigate a communication risk, and it can be found in Figure 5.

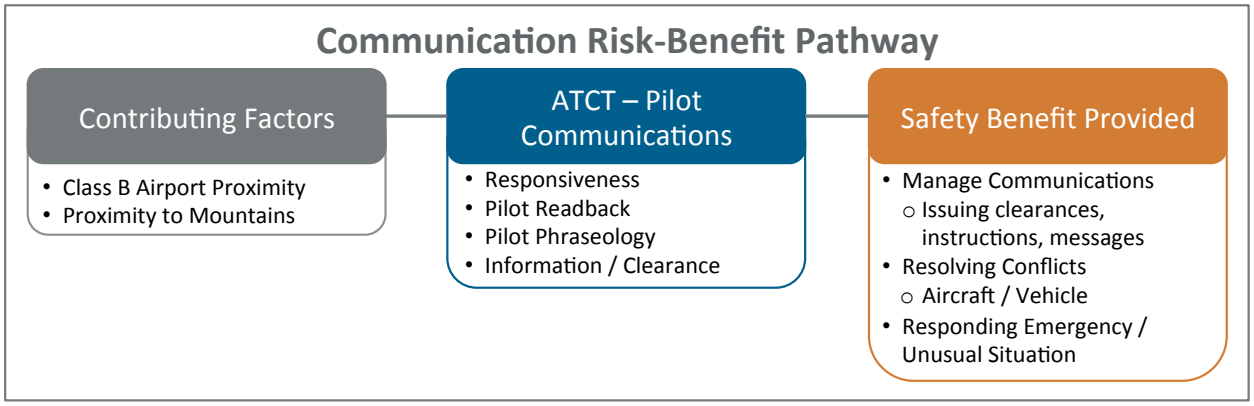

Figure 5: Communication Risk-Benefit Pathway

The central blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk to operations in the ATSAP reports. For this pathway, those factors were related to ATCT-pilot communications. When examining tower controller-pilot communications in more detail, the communication risks related to pilot responsiveness (e.g., pilots not on airport frequency or not in communication with ATC), pilot readback (e.g., ATC issuing taxiway instruction via taxiway Mike and pilot reading back instruction via taxiway Lima), pilot phraseology (e.g., pilot using non-

standard phraseology when stating location), and information / clearance (e.g., pilot not understanding takeoff instructions to avoid prohibited airspace). Table 17 lists the overall communication risk level of occurrence and the communication factors' level of occurrence.

Table 17: Risk Factor Classification Level – Communication Risk -Benefit Pathway

Risk Factor	Percentage of Classified Reports
ATCT – Pilot Communications	**26.42% of ATSAP Reports**
Responsiveness	7.55% of ATSAP Reports
Pilot Readback	7.55% of ATSAP Reports
Pilot Phraseology	7.55% of ATSAP Reports
Information / Clearance	5.66% of ATSAP Reports

The left gray box in the risk-benefit pathway graphic depicts the contributing factors associated with the communication risk factors. For the communications risk-benefit pathway, the contributing factors were found to be Class B airport proximity and proximity to mountains with Table 18 showing the level of classification for each contributing factor.

Table 18: Contributing Factors Classification Level – Communications Risk-Benefit Pathway

Contributing Factor	Percentage of Sampled Airports
Class B Airport Proximity	34.29% of the Sampled Towered Airports
Proximity to Mountains	14.29% of the Sampled Towered Airports

In order for the contributing factor to be included in the pathway, at least one of the contributing factors had to be found statically significantly associated with at least one of the risk factors. Table 19 depicts the associations and their odds ratios between the contributing factors and risk factors for the communications risk-benefit pathway.

Table 19: Contributing Factors – Risk Factors Associations Odds Ratios – Static Risk-Benefit Pathway

	Risk Factors
Contributing Factors	ATCT – Pilot Communications
Class B Airport Proximity	3.18
Proximity to Mountains	2.32

The right orange box in the risk-benefit pathway graphic depicts the safety benefits being provided by a controller through safety-critical tasks. These safety-critical tasks illustrate how a controller identified, responded to, and recovered from the communication risk. For the communication risk-benefit pathway, the safety benefits being provided by tower controllers are tasks related to managing communications by issuing clearances, instructions, and messages to pilots; resolving aircraft – vehicle conflicts; and responding to emergencies and unusual situations. Table 20 shows the level of occurrence for the benefit tasks.

Table 20: Contributing Factor Classification Level – Communications Risk-Benefit Pathway

Benefit	Percentage of Reports
Managing Communications – Issuing clearances, instructions, and messages	24.53% of ATSAP Reports
Responding to Emergencies / Unusual Situations	17.92% of ATSAP Reports
Resolving Conflicts – Aircraft / Vehicle	12.26% of ATSAP Reports

Table 21 shows the associations between the benefit tasks and the communications risk.

Table 21: Risk Factors Safety Benefit Associations Odds Ratios – Static Risk – Benefit Pathway

	Risk Factor
Safety Benefit	ATCT – Pilot Communications
Issuing Clearances, Instructions, and Messages (S07)	2.72
Resolving Conflicts – Aircraft / Vehicle (S23)	2.77
Responding to Emergencies / Unusual Situations (A11)	8.10

Human Factors Safety-Benefit Pathways for Non-Towered Airports

The safety potentials that a tower controller could provide to the pilots and other members of the flying community were examined by assessing ASRS safety reports from pilots at non-towered airports. Five risk-benefit pathways emerge from the data and will be explained in the following sections.

- Prevention Risk-Benefit Pathways
  - Prevention Pathway for Managing Air Traffic
  - Prevention Pathway for Managing Departing and Arriving Traffic
- Recovery Risk-Benefit Pathways
  - Prevention Pathway for Resolving Conflicts
  - Recovery Pathway for Managing Departing and Arriving Traffic
- Potential Safety-Benefit Pathway for Airport Characteristics

The human factors safety-benefit pathways represent key associations among AirTracs factors, safety-critical tasks, and airport characteristics. The relationships underlying the benefit pathways include the key risk factors and safety benefits and their associations found significant with the statistical tests described in the methodology section of the report. The overall AirTracs and SJA safety-critical task application results from the non-towered airport analysis can be found in Appendix F.

Prevention Pathway for Managing Air Traffic at Non-Towered Airports

The first human factors-safety risk-benefit pathway incorporates how a controller has the potential to prevent risks at a non-towered airport by managing air traffic and can be found in Figure 6.

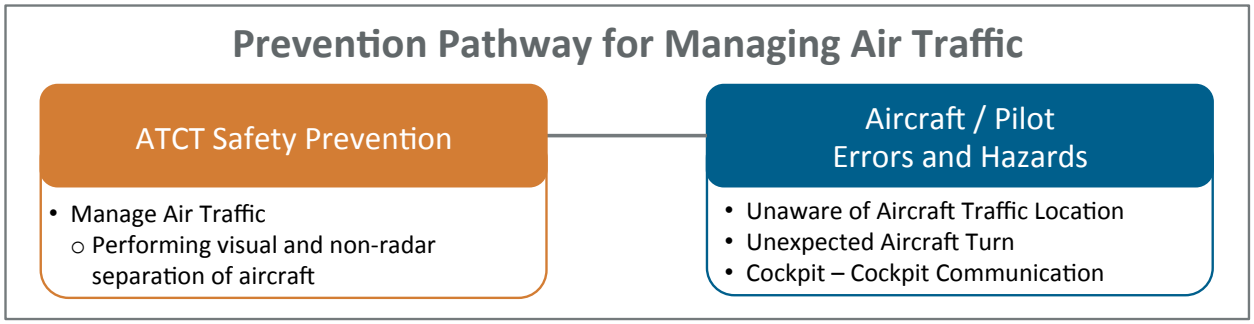

Figure 6: Prevention Pathway for Managing Air Traffic

The right blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk to operations in the ASRS reports. The risk classified in the ASRS reports were factors from the Modified AirTracs analysis. For this prevention pathway, the risk factors were related to aircraft / pilot errors and hazards and were found to be pilot unaware of other aircraft traffic location, aircraft executed unexpected turn, and cockpit – cockpit communications. Table 22 lists the classification level for each risk factor. The values in Table 22 can be interpreted in the following way: in 50% of the ASRS reports classified the reporting pilot was unaware of surrounding aircraft traffic's location.

Table 22: Risk Factor Classification Level – Prevention Pathway for Managing Air Traffic

Risk Factor	Percentage of Classified Reports
Cockpit – Cockpit Communications	61.36% of ASRS Reports
Unaware of Aircraft Traffic Location	50.00% of ASRS Reports
Unexpected Aircraft Turn	31.82% of ASRS Reports

The left orange box in the risk-benefit pathway graphic depicts the safety benefits that a controller could provide to mitigate and prevent the risk factors at non-towered airports. For this prevention pathway, the potential safety-critical prevention tasks are related to how a controller manages air traffic by performing visual and non-radar separation of aircraft. Table 23 lists the classification level for each potential prevention benefit. The values in Table 23 can be interpreted in the following way: in 59.09% of the ASRS reports classified, a controller potentially could have performed tasks related to performing visual separation of aircraft to prevent an adverse event.

Table 23: Potential Prevention Benefit Level – Prevention Pathway for Managing Air Traffic

Potential Prevention Benefit	Percentage of Classified Reports
Manage Air Traffic	70.45% of ASRS Reports
Performing non-radar separation of aircraft	61.36% of ASRS Reports
Performing visual separation of aircraft	59.09% of ASRS Reports

In order for the potential prevention benefit to be included in the pathway, at least one of the risk factors had to be found statically significantly associated with at least one of the safety benefits. Table 24 depicts the associations and their odds ratios. For those pairings with odds ratios, the pairing was first found to be statistically significant via the Pearson's Chi Square test or Fisher's Exact test ($p < 0.05$). Upon being found significant, the odds ratio for the pairing was determined. The odds ratio can be interpreted in the following way: when a report was found to include an unexpected aircraft turn as a risk factor, the odds of the report including the potential preventative benefit tasks associated with managing air traffic were 4.00 times greater than those reports that did not include an unexpected turn.

Table 24: Risk Factors Safety Benefit Associations Odds Ratios – Prevention Pathway for Managing Air Traffic

	Risk Factor		
Potential Prevention Benefit	Unaware of Aircraft Traffic Location	Unexpected Aircraft Turn	Cockpit – Cockpit Communication
Manage Air Traffic (A4)	5.28	4.00	3.91
Performing Visual Separation of Aircraft (S13)	7.88		3.39
Perform Non-Radar Separation of Aircraft (S14)	4.08		4.08

Prevention Pathway for Managing Departing and Arriving Traffic at Non-Towered Airports

The second human factors-safety risk-benefit pathway incorporates how a controller has the potential to prevent risks at a non-towered airport by managing departing and arriving traffic and can be found in Figure 7.

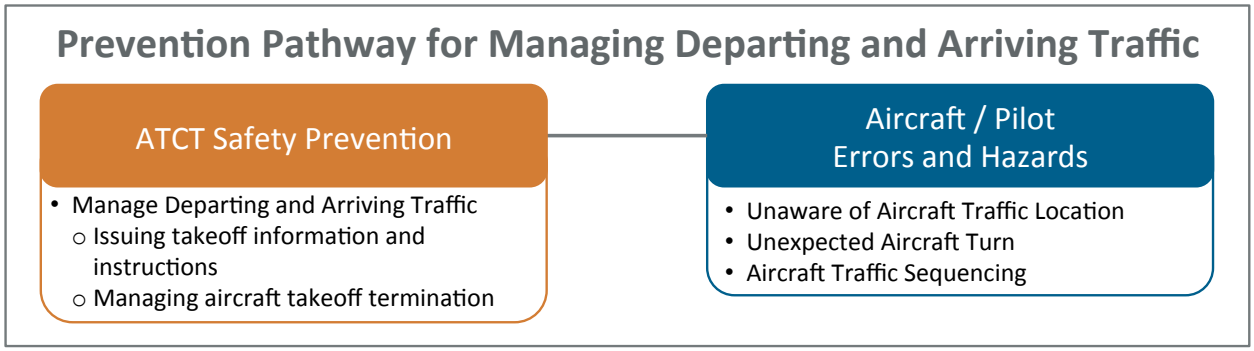

Figure 7: Prevention Pathway for Managing Departing and Arriving Traffic

The right blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk to operations in the ASRS reports. For this prevention pathway, the risk factors were related to aircraft / pilot errors and hazards and were found to be pilot unaware of other aircraft traffic location, aircraft executed unexpected turn, and aircraft traffic sequencing. Table 25 lists the classification level for each risk factor.

Table 25: Risk Factor Classification Level – Prevention Pathway for Managing Departing and Arriving Traffic

Risk Factor	Percentage of Classified Reports
Unaware of Aircraft Traffic Location	50.00% of ASRS Reports
Unexpected Aircraft Turn	31.82% of ASRS Reports
Aircraft Traffic Sequencing	29.55% of ASRS Reports

The left orange box in the risk-benefit pathway graphic depicts the safety benefits that a controller could provide to mitigate and prevent the risk factors at non-towered airports. For this prevention pathway, the potential safety-critical prevention tasks are related to how a controller manages departing and arriving traffic by issuing takeoff information and instructions and managing aircraft takeoff terminations. Table 26 lists the classification level for each potential prevention benefit.

Table 26: Potential Prevention Benefit Level – Prevention Pathway for Managing Departing and Arriving Traffic

Potential Prevention Benefit	Percentage of Classified Reports
Manage Departing and Arriving Traffic	79.55% of ASRS Reports
Issuing Takeoff Information and Instructions	27.27% of ASRS Reports
Managing Aircraft Takeoff Termination	25.00% of ASRS Reports

In order for the potential prevention benefit to be included in the pathway, at least one of the risk factors had to be found statically significantly associated with at least one of the safety benefits. Table 27 depicts the associations and their odds ratios.

Table 27: Risk Factors Safety Benefit Associations Odds Ratios – Prevention Pathway for Managing Departing and Arriving Traffic

	Risk Factor		
Potential Prevention Benefit	Unaware of Aircraft Traffic Location	Unexpected Aircraft Turn	Aircraft Traffic Sequencing
Issuing Takeoff Information and Instructions (S26)	4.38	8.67	10.80
Managing Aircraft Takeoff Termination (S27)		6.5	7.88

Recovery Pathway for Resolving Conflicts at Non-Towered Airports

The third human factors-safety risk-benefit pathway incorporates how a controller has the potential to assist in the recovery from conflicts at a non-towered airport and can be found in Figure 8.

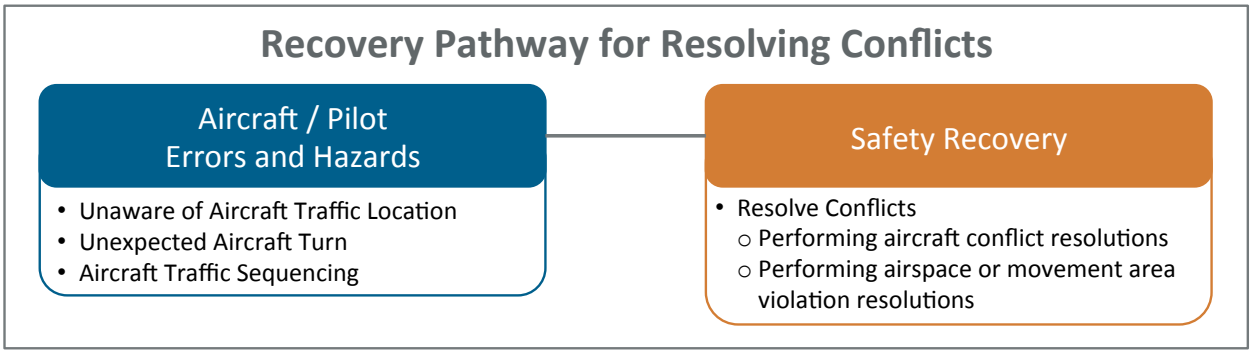

Figure 8: Recovery Pathway for Resolving Conflicts

The left blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk to operations in the ASRS reports. The risk classified in the ASRS reports were factors from the Modified AirTracs analysis. For this recovery pathway, the risk factors were related to aircraft / pilot errors and hazards and were found to be pilot unaware of other aircraft traffic location, aircraft executed unexpected turn, and aircraft traffic sequencing. Table 28 lists the classification level for each risk factor.

Table 28: Risk Factor Classification Level – Recovery Pathway for Resolving Conflicts

Risk Factor	Percentage of Classified Reports
Unaware of Aircraft Traffic Location	50.00% of ASRS Reports
Unexpected Aircraft Turn	31.82% of ASRS Reports
Aircraft Traffic Sequencing	29.55% of ASRS Reports

The right orange box in the risk-benefit pathway graphic depicts the safety benefits that a controller could provide to respond to the risk factor at non-towered airports via recovery efforts. For this recovery pathway, the potential safety-critical recovery tasks are related to how a controller resolves conflicts by performing aircraft conflict resolutions and performing airspace or movement area violation resolutions. Table 29 lists the classification level for each potential recovery benefit. The values in Table 29 can be interpreted in the following way: in 75.99% of the ASRS reports classified, a controller potentially could have assisted in recovery from an adverse event by performing aircraft conflict resolutions.

Table 29: Potential Recovery Benefit Level – Recovery Pathway for Resolving Conflicts

Potential Recovery Benefit	Percentage of Classified Reports
Resolving Conflicts	86.36% of ASRS Reports
Performing Aircraft Conflict Resolutions	75.00% of ASRS Reports
Performing Airspace or Movement Area Violation Resolutions	43.18% of ASRS Reports

In order for the potential recovery benefit to be included in the pathway, at least one of the risk factors had to be found statically significantly associated with at least one of the safety benefits. Table 30 depicts the associations and their odds ratios. For those pairings with odds ratios, the pairing was first found to be statistically significant via the Pearson's Chi Square test or Fisher's Exact test ($p < 0.05$). Upon being found significant, the odds ratio for the pairing was determined. The odds ratio can be interpreted in the following way: when a report was found to include an unexpected aircraft turn as a risk factor, the odds of the report including the potential recovery benefit tasks associated with performing airspace violation resolutions were 3.60 times greater than those reports that did not include an unexpected turn.

Table 30: Risk Factors Safety Benefit Associations Odds Ratios – Recovery Pathway for Resolving Conflicts

	Risk Factor		
Potential Recovery Benefit	Unaware of Aircraft Traffic Location	Unexpected Aircraft Turn	Aircraft Traffic Sequencing
Resolving Conflicts (A5)	6.18		
Performing Aircraft Conflict Resolutions (S20)	6.92		5.71
Performing Airspace or Movement Area Violation Resolutions (S22)		3.60	4.72

Recovery Pathway for Responding to Emergencies and Unusual Situations at Non-Towered Airports

The fourth human factors-safety risk-benefit pathway incorporates how a controller has the potential to assist in the response to emergencies or unusual situations at a non-towered airport and can be found in Figure 9.

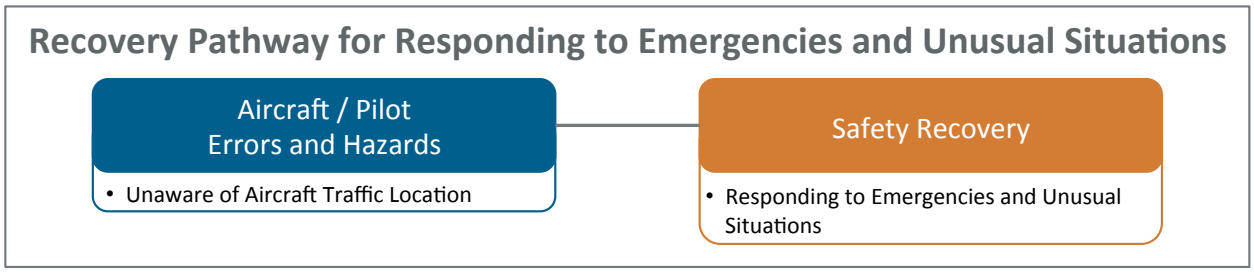

Figure 9: Recovery Pathway for Responding to Emergencies and Unusual Situations

The left blue box in the risk-benefit pathway graphic depicts the AirTracs factors that presented a key risk to operations in the ASRS reports. For this recovery pathway, the risk factors were related to aircraft / pilot errors and hazards and were found to be pilot unaware of other aircraft traffic location. Table 31 lists the classification level for each risk factor.

Table 31: Risk Factor Classification Level – Recovery Pathway for Responding to Emergencies and Unusual Situations

Risk Factor	Percentage of Classified Reports
Unaware of Aircraft Traffic Location	50.00% of ASRS Reports

The right orange box in the risk-benefit pathway graphic depicts the safety benefits that a controller could provide to respond to the risk factors at non-towered airports via recovery efforts. For this recovery pathway, the potential safety-critical recovery tasks are related to how a controller responds to emergencies or unusual situations. Table 32 lists the classification level for each potential recovery benefit.

Table 32: Potential Recovery Benefit Level – Recovery Pathway for Responding to Emergencies and Unusual Situations

Potential Recovery Benefit	Percentage of Classified Reports
Responding to Emergencies and Unusual Situations	18.18% of ASRS Reports

In order for the potential recovery benefit to be included in the pathway, at least one of the risk factors had to be found statically significantly associated with at least one of the safety benefits. Table 33 depicts the associations and their odds ratios.

Table 33: Risk Factors Safety Benefit Associations Odds Ratios – Recovery Pathway for Responding to Emergencies and Unusual Situations

	Risk Factor
Potential Recovery Benefit	Unaware of Aircraft Traffic Location
Responding to Emergencies and Unusual Situations (A11)	9.80

Potential Safety-Benefit Pathway for Airport Characteristics

The final human factors-safety risk-benefits pathway incorporates how a controller at a non-towered airport has the potential to prevent conflicts and to respond to airport characteristics that may present a hazard to safe operations. This pathway can be found in Figure 10.

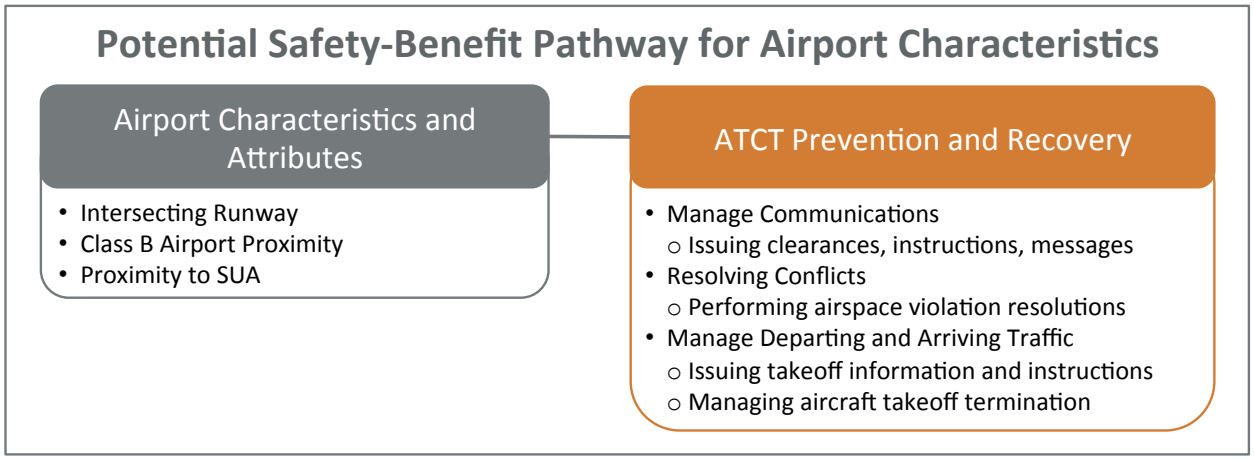

Figure 10: Potential Safety-Benefit Pathway for Airport Characteristics

The left gray box in the risk-benefit pathway graphic depicts airport characteristics and attributes for the non-towered airports sample set. For this potential safety-benefit pathway, the factors were intersecting runways, Class B airport proximity, Class C airport proximity, proximity to SUA, and satellite airport. Table 34 lists the classification level for each factor. The values in Table 34 can be interpreted in the following way: 47.37% of the sampled non-towered airports had intersecting runways.

Table 34: Factor Classification Level – Potential Safety-Benefit Pathway for Airport Characteristics

Factor	Percentage of Sampled Airports
Intersecting Runways	47.37% of the Sampled Non-Towered Airports
Proximity to SUA	42.11% of the Sampled Non-Towered Airports
Class B Airport Proximity	31.58% of the Sampled Non-Towered Airports

The right orange box in the risk-benefit pathway graphic depicts the safety benefits that a controller could provide to respond to the airport characteristics and attributes at non-towered airports via recovery efforts. For this pathway, the potential safety-critical tasks are related to

managing communications, managing air traffic, resolving conflicts, and managing departing and arriving traffic. Table 35 lists the classification level for each potential recovery benefit.

Table 35: Potential Recovery Benefit Level – Potential Safety-Benefit Pathway for Airport Characteristics

Potential ATCT Safety-Critical Task Benefit	Percentage of Classified Reports
Manage Communications	40.91% of ASRS Reports
Issuing clearance, instructions, messages	38.64% of ASRS Reports
Resolve Conflicts	86.36% of ASRS Reports
Performing Airspace or Movement Area Violation Resolutions	43.18% of ASRS Reports
Manage Departing and Arriving Traffic	79.55% of ASRS Reports
Issuing takeoff information and instructions	27.27% of ASRS Reports
Managing aircraft takeoff termination	25.00% of ASRS Reports

In order for the potential safety-critical task benefit to be included in the pathway, at least one of the risk factors had to have a statically significant association with at least one of the safety benefits. Table 36 depicts the associations and their odds ratios. For those pairings with odds ratios, the pairing was first found to be statistically significant via the Pearson's Chi Square test or Fisher's Exact test ($p < 0.05$). Upon being found significant, the odds ratio for the pairing was determined. The odds ratio can be interpreted in the following way: when an airport had intersecting runways, the odds of a controller potentially issuing an aircraft takeoff termination in response to a safety event were 7.37 times greater than an airport without an intersecting runway.

Table 36: Risk Factors Safety Benefit Associations Odds Ratios – Potential Safety-Benefit Pathway for Airport Characteristics

	Airport Characteristic		
Potential Safety Benefit	Intersecting Runways	Class B Airport Proximity	Proximity to SUA
Manage Communications (A02)			3.54
Issue clearance, instruction, or message (S07)			2.86
Performing airspace or movement area violation resolutions (S22)			4.41
Issuing takeoff information and instructions (S26)		7.53	
Managing aircraft takeoff terminations (S27)	7.37	6.50	

NTSB Report Analysis

Building upon the AVP review of NTSB reports (FAA, 2014), the panel of human factors, cockpit, and ATC SMEs reviewed the 24 NTSB reports to identify causal factors, preventative safety-critical tasks, and recovery safety-critical tasks. From the review, one of the reports was eliminated due to lack of information. In Figure 10 below are sample findings for the review of one NTSB report with the full findings in Appendix G.

NTSB Reports CHI07FA140A

Causal and Contributory Factors

- Visual Scan: "The inadequate visual lookout of the pilots in both airplanes, and their failure to maintain clearance from each other's airplane."
- Vision Restriction: Cessna (high wing) climbing aircraft and Beech Bonanza (low wing) descending aircraft. "The radar showed that airplane descending and returning to ISZ. The radar showed another airplane departing ISZ to the north about 1500. The second airplane was climbing. The radar data showed that about 1502, the airplanes' radar returns came together."
- Training: "certified flight instructor (CFI) and dual student aboard the Cessna"

ATCT Controller Prevention Tasks

- Manage Communications: Issuing clearances, instructions, or other messages
- Manage Air Traffic: Performing visual and non-radar separation of aircraft and vehicles
- Manage Departing and Arriving Traffic: 1) Issuing takeoff information and instructions and 2) Managing arrivals

ATCT Controller Recovery Tasks

- Resolve Conflicts: Performing aircraft conflict resolutions

Figure 11: Sample Assessment of NTSB Report

DISCUSSION OF FINDINGS

This report outlined the results and conclusions from a systematic assessment of the controller benefits present in NAS operations with a focus on low volume operations. The study included three primary activities to assess controller safety benefits. First, an assessment of tower controller tasks was completed to identify safety-critical controller tasks performed by tower controllers. Second, an assessment of the operational impact of these safety-critical tasks was conducted for towers in Class D airspace. Finally, an evaluation of safety events occurring in non-towered airports was conducted to identify the missing controller tasks that could have potentially prevented the adverse event or aided in the recovery from the adverse event.

When examining the risk-benefit pathways in the aggregate, nine static airport characteristics were identified as potential risks to pilots and drivers. Table 37 prioritizes those airport characteristics based on the number of times the characteristic appeared in a risk-benefit pathway.

Table 37: Airport Characteristics Priority

Airport Characteristic	Priority
Class B Airport Proximity	1
Intersecting Runways Proximity to Mountains Proximity to SUA	2
Weather Satellite Airport Part 141 Flight School Class C Airport Proximity Inadequate Signage / Ground Markings	3

An additional nine safety risks or hazards were identified and included in the risk-benefit pathways. These nine safety risks represent actual hazards present in the safety reports. Table 38 groups and prioritizes those safety risks based on the number of times the risk appeared in a risk-benefit pathway.

Table 38: Identified Safety Risk Priorities

Identified Risk or Hazard	Priority
Aircraft – Aircraft Traffic Pilot Unaware of Aircraft Traffic Location Unexpected Aircraft Turn or Movement Pilot Deviation	1

Identified Risk or Hazard	Priority
Pilot Communications Cockpit – Cockpit Communications Misunderstanding of Information / Clearance Pilot Readback Pilot Phraseology Responsiveness	2
Airport Surrounding Airspace Traffic Aircraft Traffic Sequencing Airport Aircraft Traffic	3
Airport Surface Traffic Ground Vehicle Traffic	4

In response to those airport characteristics and identified safety risks, eight controller benefits were identified as preventative or recovery benefits. Table 39 groups and prioritizes those safety benefits based on the number of times the benefit appeared in a risk-benefit pathway.

Table 39: Identified Safety-Benefit Priorities

Identified Safety Benefit	Priority
Resolving Conflicts Airspace or Movement Area Conflict Aircraft to Aircraft Conflict Aircraft to Vehicle Conflict	1
Responding to Emergency or Unusual Situations	2
Performing Separation of Aircraft and Vehicles	3
Issuing Clearances, Instructions, or Messages	4
Managing Departing and Arriving Traffic Issuing Takeoff Information and Instructions Managing Aircraft Takeoff Termination	5

It is important to note that these findings are based on voluntary safety reports. Those safety reports are not intended to be an all-encompassing view of operations. However, those voluntary safety reports typically include a narrative where the reporter, either a controller or pilot, can provide details into a safety event and daily operations. It is suggested that these findings should be paired with additional safety findings that are not voluntary reporting systems, such as runway safety data. Pairing the risk-benefit pathways findings with traditional safety data and frequency analyses will help to develop a thorough view of airport operations and how a controller can provide and has provided a safety benefit in response to hazards or airport characteristics.

CONCLUSION

This report presented the results from a systematic assessment of the controller benefits present in NAS operations with a focus on low volume operations. The study included three primary activities to assess controller safety benefits. First, an assessment of tower controller tasks was completed to identify safety critical controller tasks performed by tower controllers. Second, an assessment of the operational impact of these safety critical tasks was conducted for towers in Class D airspace. Finally, an evaluation of safety events occurring non-towered airports was conducted to identify the missing controller tasks that could have potentially prevented the adverse event or aided in the recovery from the adverse event. The resulting findings are currently limited to the safety-benefit pathways. It is recommended that future work aim to transform the data and findings to operationalized the applicability of the findings.

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APPENDIX A: TOWERED AND NON-TOWERED AIRPORT SAMPLE SETS

TOWERED AIRPORT SAMPLE

Airport ID	Tower Name	Location	Facility Level	Intersecting Runways	Converging Runways	Hotspots	Satellite Airports	Special Use Airspace	Class B	Class C	Mountains	Flight School	Raised Cable
LAF	Lafayette Tower	Lafayette, IN	4	X									
AFW	Alliance Tower	Fort Worth, TX	5			X	X		X				
AGC	Allegheny Tower	Pittsburgh, PA	5	X					X			X	
ALO	Waterloo Municipal Tower	Waterloo, IA	5	X		X	X						
APC	Napa Tower	NAPA, CA	5	X		X		X			X	X	
ARB	Ann Arbor Tower	Ann Arbor, MI	5	X		X	X		X			X	
ARR	Aurora Tower	Chicago/Aurora, IL	5	X			X					X	
ASE	Aspen Pitkin County Tower	Aspen, CO	5			X	X				X		
BIS	Bismarck Municipal Tower	Bismarck, ND	5	X									
CDW	Caldwell Tower	Caldwell, NJ	5			X	X		X			X	
CPR	Casper Tower	Casper, WY	5	X		X					X	X	
DPA	Dupage Tower	Chicago, IL	5	X			X		X			X	
EMT	El Monte Tower	El Monte, CA	5				X			X	X	X	
FTW	Meacham Tower	Fort Worth, TX	5	X			X		X			X	
GCN	Grand Canyon Tower	Grand Canyon, AZ	5					X					
HEF	Manassas Tower	Washington, DC	5				X	X	X			X	
JNU	Juneau Tower	Juneau, AK	5								X		
LOU	Bowman Tower	Louisville, KY	5	X		X				X		X	
MFD	Mansfield Lahm Municipal Tower	Mansfield, OH	5	X									
MIC	Crystal Tower	Minneapolis, MN	5	X		X			X			X	
MKC	Downtown Tower	Kansas City, MO	5	X		X			X			X	

Airport ID	Tower Name	Location	Facility Level	Intersecting Runways	Converging Runways	Hotspots	Satellite Airports	Special Use Airspace	Class B	Class C	Mountains	Flight School	Raised Cable
NEW	Lakefront Tower	New Orleans, LA	5	X		X		X	X			X	
PNE	Northeast Philadelphia Tower	Philadelphia, PA	5	X			X		X			X	
POU	Poughkeepsie Tower	Poughkeepsie, NY	5	X								X	
SCK	Stockton Tower	Stockton, CA	5			X						X	
STS	Sonoma Tower	Santa Rosa, CA	5	X		X							
SUX	Sioux City/Sioux Gateway Tower	Sioux City, IA	5	X		X	X						X
TVC	Traverse City Tower	Traverse City, MI	5	X								X	
TWF	Twin Falls Tower	Twin Falls, ID	5	X									
YIP	Willow Run Tower	Detroit, MI	5	X		X	X		X			X	
FLO	Florence City Tower	Florence, SC	6	X			X						
CKB	Clarksburg/Benedum Tower	Clarksburg, WV	6									X	
ACT	Waco Municipal Tower	Waco, TX	6		X	X	X						
RST	Rochester International Tower	Rochester, MN	6	X		X							
HUF	Terre Haute/Hulman Rgnl Tower	Terre Haute, IN	6	X									

TOWERED AIRPORT SAMPLE

Airport ID	Tower Name	Annual IFR Airport Ops	Average Daily IFR Ops	IFR Non Military	Military % Ops
LAF	Lafayette Tower	69612	191	69504	0.16%
AFW	Alliance Tower	88830	243	71872	19.09%
AGC	Allegheny Tower	38783	106	38470	0.81%
ALO	Waterloo Municipal Tower	14490	40	13580	6.28%
APC	Napa Tower	33393	91	33273	0.36%
ARB	Ann Arbor Tower	39916	109	39909	0.02%
ARR	Aurora Tower	42692	117	42287	0.95%
ASE	Aspen Pitkin County Tower	35037	96	34976	0.17%
BIS	Bismarck Municipal Tower	35804	98	33050	7.69%
CDW	Caldwell Tower	37217	102	37071	0.39%
CPR	Casper Tower	28640	78	28083	1.94%
DPA	Dupage Tower	54054	148	53863	0.35%
EMT	El Monte Tower	44573	122	44566	0.02%
FTW	Meacham Tower	52411	144	51864	1.04%
GCN	Grand Canyon Tower	4251	12	3519	17.22%
HEF	Manassas Tower	57616	158	57475	0.24%
JNU	Juneau Tower	16805	46	16164	3.81%
LOU	Bowman Tower	42400	116	42228	0.41%
MFD	Mansfield Lahm Municipal Tower	13712	38	10006	27.03%
MIC	Crystal Tower	22920	63	22840	0.35%
MKC	Downtown Tower	48101	132	47056	2.17%
NEW	Lakefront Tower	40033	110	37383	6.62%
PNE	Northeast Philadelphia Tower	38255	105	38214	0.11%
POU	Poughkeepsie Tower	43531	119	42957	1.32%
SCK	Stockton Tower	28419	78	25905	8.85%
STS	Sonoma Tower	37787	104	37598	0.50%
SUX	Sioux City/Sioux Gateway Tower	13569	37	10721	20.99%
TVC	Traverse City Tower	62805	172	55542	11.56%
TWF	Twin Falls Tower	17436	48	16358	6.18%

Airport ID	Tower Name	Annual IFR Airport Ops	Average Daily IFR Ops	IFR Non Military	Military % Ops
YIP	Willow Run Tower	53525	147	52673	1.59%
FLO	Florence City Tower	13228	36	11491	13.13%
CKB	Clarksburg/Benedum Tower	27483	75	12710	53.75%
ACT	Waco Municipal Tower	21212	58	18607	12.28%
RST	Rochester International Tower	32282	88	29953	7.21%
HUF	Terre Haute/Hulman Rgnl Tower	28508	78	27647	3.02%

NON-TOWERED AIRPORT SAMPLE

Airport ID	Tower Name	Location	Intersecting Runways	Converging Runways	Satellite Airports	Special Use Airspace	Class B	Class C	Mountains	Flight School	Raised Cable
AAO	Colonel James Jabara Airport	Wichita, KS			X	X		X			
BLM	Monmouth Executive Airport	Belmar/Farmingdale, NJ	X			X	X				
C09	Morris Municipal Airport-James R. Washburn Field	Morris, IL					X				
CJR	Culpeper Regional Airport	Culpeper, VA				X	X		X		
DMW	Carroll County Regional Airport/Jack B Poage Field	Westminster, MD				X	X				
EAT	Pangborn Memorial Airport	Wenatchee, WA	X						X		
F45	North Palm Beach County General Aviation Airport	West Palm Beach, FL	X		X	X		X			
GRD	Greenwood County Airport	Greenwood, SC									
GVL	Lee Gilmer Memorial Airport	Gainesville, GA	X				X				
IGQ	Lansing Municipal Airport	Chicago, IL		X			X	X			
KTN	Ketchikan International Airport	Ketchikan, AK							X	X	
L71	California City Municipal Airport	California City, CA				X			X		
LUM	Menomonie Municipal Airport-Score Field	Menomonie, WI	X								
MCE	Merced Regional Airport/Macready Field	Merced, CA									
MCW	Mason City Municipal Airport	Mason City, IA	X								
OKK	Kokomo Municipal Airport	Kokomo, IN	X			X					
PRB	Paso Robles Municipal Airport	Paso Robles, CA		X		X			X		
SGT	Stuttgart Municipal Airport	Stuttgart, AR	X								
TRK	Truckee-Tahoe Airport	Truckee, CA	X					X	X		

NON-TOWERED AIRPORT SAMPLE

Airport ID	Tower Name	Annual IFR Airport Ops	Avg Daily IFR Ops	IFR Non Military	Military % Ops
AAO	Colonel James Jabara Airport	38300	105	38300	0.00%
BLM	Monmouth Executive Airport	57229	157	57229	0.00%
C09	Morris Municipal Airport-James R. Washburn Field	42300	116	42000	0.71%
CJR	Culpeper Regional Airport	60125	165	56925	5.32%
DMW	Carroll County Regional Airport/Jack B Poage Field	69050	189	68960	0.13%
EAT	Pangborn Memorial Airport	42492	116	42392	0.24%
F45	North Palm Beach County General Aviation Airport	44262	121	44262	0.00%
GRD	Greenwood County Airport	40000	110	39900	0.25%
GVL	Lee Gilmer Memorial Airport	38800	106	38300	1.30%
IGQ	Lansing Municipal Airport	54000	148	54000	0.00%
KTN	Ketchikan International Airport	16208	44	16064	0.89%
L71	California City Municipal Airport	37200	102	37000	0.54%
LUM	Menomonie Municipal Airport-Score Field	13550	37	13550	0.00%
MCE	Merced Regional Airport/Macready Field	53250	146	52750	0.94%
MCW	Mason City Municipal Airport	33368	91	33308	0.18%
OKK	Kokomo Municipal Airport	17043	47	16368	3.96%
PRB	Paso Robles Municipal Airport	34250	94	33000	3.65%
SGT	Stuttgart Municipal Airport	40200	110	37200	7.46%
TRK	Truckee-Tahoe Airport	35000	96	34976	0.07%

APPENDIX B: DETAILED AIRTRACS FACTORS

Operator Actions

Acts

Sensory

Se01	Auditory Perception
Se02	Visual Perception
Se03	Temporal Perception

Decision

De01	Alert Comprehension
De02	Knowledge / Planning
De03	Prioritization
De04	Tool / Equipment Use

Execution

Ex01	Controller Technique
Ex02	Attention Act
Ex03	Communication Act
Ex04	Inadvertent Operation

Violation

Willful Violations

V01	Willful Violations

Outside Influence

OI01	Airline Influences
OI02	Military Influences
OI03	Contract Towers
OI04	Other ANSPs
OI99	Other Influences

Severity

Level	Description
0	No Event
1	Near Airspace Violation
2	Airspace Violation
3	Near LOSS / RI
4	LOSS / RI
5	Collision

Operator Context

Controller Workspace

Physical Environment

PE01	Workstation / Work Area
PE02	Lighting
PE03	Noise Interference
PE04	Vision Restricted

Technological Environment

TE01	Communication Equipment
TE02	Display / Interface
TE03	Software / Automation
TE04	Warnings / Alerts
TE05	Data Block
TE06	Flight Progress Strips
TE07	Field Equipment

Controller Readiness

Cognitive and Physiological Factors

CPF01	Working Memory / Distraction
CPF02	Workload
a	High Workload
b	Low Workload
CPF03	Complacency / Vigilance
CPF04	Automation Reliance
CPF05	Expectation Bias
CPF06	Fatigue

Knowledge / Experience

KE01	On-the-Job Training/Developmental
KE02	Trainer Intervention
KE03	CPC Experience
KE04	Unfamiliar Task/Procedure

NAS Interactions

Airport Conditions

APC01	Combined Positions
APC02	Ground Vehicle Traffic
APC03	Aircraft Traffic
APC04	Airport Weather
a	Visibility / IMC
b	Wind
c	Other Weather
APC05	Signage/Lighting/Ground Markings
APC06	Construction
APC07	Layout/Design
APC08	Runway Conditions

Airspace Conditions

ASC01	Combined Sectors
ASC02	Combined Positions
ASC03	Sector Traffic
a	Traffic Level
b	Traffic Complexity
c	VFR Traffic
d	Restricted Airspace
ASC04	Sector Weather/Turbulence
ASC05	Sector Design

Aircraft Actions

AA01	Deviation
a	Procedures
b	ATC Instructions / Clearance
AA02	Unexpected Aircraft Performance
AA03	Aircraft Equipment/System Operation
AA04	Responding to Abnormal Situation
AA05	Go Around
AA06	Flight Planning
AA07	TCAS RA Response

Communication

CC01	Controller-Cockpit Communication
a	Readback / Hearback
b	Phraseology / Call Sign
c	Information / Clearance
d	Frequency Congestion
e	Responsiveness
CC02	Controller-Controller Communication
a	Position Relief Briefing
b	Handoff / Point-Out
c	Aircraft Information
d	Phraseology

Facility Influences

Supervisory Planning / Preparation

SP01	Facility Procedures
a	SOPs
b	LOAs
c	Checklists / Manuals
SP02	Staffing
SP03	Equipment Readiness
SP04	Training

Supervisory Operations

SO01	Sector Combination
SO02	Position Combination
SO03	Controller Assignment
SO04	Oversight / Assistance
SO05	Sector/Airport Configuration
SO06	Supervisory Coordination
a	Intra-Facility
b	Inter-Facility

Traffic Management Unit

TM01	Weather Response
TM02	Special Use Airspace
TM03	Traffic Management Initiatives
TM04	Traffic Regulation / Delivery

Agency Influences

Resource Management

RM01	Equipment/Facility Resources
RM02	Human Resources

Agency Climate

AC01	Culture
AC02	Policy

Operational Process

OP01	Procedures / Operations
a	NAS Procedures (7110.65)
b	Charts / Routes (STAR, SID)
OP02	Oversight
OP03	Response to Event / Report

APPENDIX C: AIRTRACS TAXONOMY – MODIFIED AIRTRACS

Operator Actions

Aircraft Errors

- AE01 Unaware of Aircraft Traffic Location
- AE02 Line Up on Unexpected Runway
- AE03 Gear-Up Landing
- AE04 Unexpected Turn
- AE05 Aircraft Traffic Sequence
- AE06 Missed Approach Execution
- AE07 Pilot Technique - Breaking
- AE08 Unaware of Airport / Airspace Information
- AE09 Willful Violation
- AE99 Other Aircraft Error

Outside Influence

- OI01 Airline Influences
- OI02 Military Influences
- OI03 Contract Towers
- OI04 Other ANSPs
- OI99 Other Influences

Operator Context

Controller Workspace

Physical Environment

- PE01 Workstation / Work Area
- PE02 Lighting
- PE03 Noise Interference
- PE04 Vision Restricted

Technological Environment

- TE01 Communication Equipment
- TE02 Display / Interface
- TE03 Software / Automation
- TE04 Warnings / Alerts
- TE05 Data Block
- TE06 Flight Progress Strips
- TE07 Field Equipment

Controller Readiness

Cognitive and Physiological Factors

- CPF01 Working Memory / Distraction
- CPF02 Workload
  - a High Workload
  - b Low Workload
- CPF03 Complacency / Vigilance
- CPF04 Automation Reliance
- CPF05 Expectation Bias
- CPF06 Fatigue
- CPF07 Rushed / Time Pressure

Knowledge / Experience

- KE01 On-the-Job Training/Developmental
- KE02 Trainer Intervention
- KE03 CPC Experience
- KE04 Unfamiliar Task/Procedure

NAS Interactions

Airport Conditions

- APC01 Combined Positions
- APC02 Ground Vehicle Traffic
- APC03 Aircraft Traffic
- APC04 Airport Weather
  - a Visibility / IMC
  - b Wind
- APC05 Signage/Lighting/Ground Markings
- APC06 Construction
- APC07 Layout/Design
- APC08 Runway Conditions

Airspace Conditions

- ASC01 Combined Sectors
- ASC02 Combined Positions
- ASC03 Sector Traffic
  - a Traffic Level
  - b Traffic Complexity
  - c VFR Traffic
  - d Restricted Airspace
- ASC04 Sector Weather/Turbulence
- ASC05 Sector Design

Aircraft Actions

- AA01 Deviation
  - a Procedures
  - b ATC Instructions / Clearance
- AA02 Unexpected Aircraft Performance
- AA03 Aircraft Equipment/System Operation
- AA04 Responding to Abnormal Situation
- AA05 Go Around
- AA06 Flight Planning
- AA07 TCAS RA Response

Communication

- CC01 Cockpit-Cockpit Communication
  - a Location / Intent of Other Aircraft
  - b Phraseology
  - c Wrong Frequency
  - d Responsiveness
  - e Other
- CC02 NOTAMs
- CC99 Other Communication

Facility Influences

Supervisory Planning / Preparation

- SP01 Facility Procedures
  - a SOPs
  - b LOAs
  - c Checklists / Manuals
- SP02 Staffing
- SP03 Equipment Readiness
- SP04 Training

Supervisory Operations

- SO01 Sector Combination
- SO02 Position Combination
- SO03 Controller Assignment
- SO04 Oversight / Assistance
- SO05 Sector/Airport Configuration
- SO06 Supervisory Coordination

Traffic Management Unit

- TM01 Weather Response
- TM02 Special Use Airspace
- TM03 Traffic Management Initiatives
- TM04 Traffic Regulation / Delivery

Agency Influences

Resource Management

- RM01 Equipment/Facility Resources
- RM02 Human Resources

Agency Climate

- AC01 Culture
- AC02 Policy

Operational Process

- OP01 Procedures / Operations
  - a NAS Procedures
  - b Charts / Routes (STAR, SID)
- OP02 Oversight
- OP03 Response to Event / Report

Appendix D: Safety-Critical Tasks Assessment

ATCT Activities, Sub-Activities, and Tasks **Activity (A-bold),** *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Human Performance - Safety Assessment Findings Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
A1 - Establish Situation Awareness				
S1 Assuming position responsibility				
T1 Review system status information areas to gain situation awareness	Contributes to Safety	This task supports the controller's overall situation awareness. The status information area (SIA) is a visual display of all 'outside information' affecting any of the sectors within that area, including SUA and SAA status, military operations, TMU initiatives, and other essential information.		SIA gives controller a quick reference to the times and altitudes of SAA, SUA, and or TFR activity so the controller can easily avoid an airspace violation.
T3 Receive briefing from controller being relieved	Contributes to Safety	The relief briefing is where the outgoing controller passes critical information to the incoming controller, in particular, potential conflicts and other impending traffic or weather situations. The incoming controller will be building current knowledge based on the briefing and planning the first few actions upon assuming responsibility for the position.		In the position relief briefing, the outgoing controller informs the incoming controller of the glider airspace in use creating a SAA that should be avoided by all traffic including general aviation.
T10 Update automatic terminal information service (ATIS) broadcast	*Critical to Safety*		This task provides a direct safety benefit to pilots. It informs a pilot of the runways and approaches in use, the weather conditions, and any top-priority NOTAMs.	The controller updates the ATIS broadcast announcing the IMC impending weather.
S2 Assessing position data				
T11 Scan control environment to gather information about aircraft and vehicles	Contributes to Safety	Scanning of the control environment is how controllers verify that aircraft and ground vehicles are conforming with their stated intentions and/or control instructions. Identifying non-conformance in a timely fashion can prevent runway incursions, airspace violations, losses of separation, and potential or possible emergency situations.	This task is an essential component of preventing collisions, preventing accidents, and assisting with emergency situations. ATC serves as an additional set of eyes and ears with an often better perspective than the pilot.	Identify that aircraft gear is not down on short final. Observe aircraft initiate assigned turn in the correct direction to ensure separation. Observe a vehicle enter an active runway without a clearance.
T12 Scan control environment to gather current and trend weather data	Contributes to Safety	This task enhances the safety of operations. Weather can quickly impact safety of VFR operations and the ability to use visual separation between IFR aircraft. Observing an approaching change in the weather that impacts an aircraft operation will ensure that those operations can be safely terminated or changed to meet the conditions.	This task can result in safety-related weather information reaching pilots so that they can make better informed decisions.	Observe fog approaching rapidly, notifies pattern aircraft and suggest full stop or departure from the airport. Observe a scattered ceiling layer becoming a broken layer and ensure that a weather special observation is taken and a new ATIS indicates the change. Observe thunderstorm cells forming and alert affected aircraft.
T13 Scan control environment for information regarding temporary and permanent changes to the NAS	Contributes to Safety	Temporary changes to the NAS can include construction, debris on the runway, or any other temporary situation impact NAS operations. Awareness of these changes allows controllers to issue information and instructions to aircraft that increase safety of operations and determine actions that prevent an adverse event.	This task can help a pilot avoid hazards both in flight and on the airport surface (e.g., temporary cranes, snow plows, construction barricades, shortened runways).	Observe debris or animal on the runway surface and send aircraft around to avoid the obstacle. Inform pilot of crane in the area of the runway.
T14 Scan control environment for information about traffic outside your airspace/movement area	Contributes to Safety	By scanning outside the control environment, the controller can anticipate potential incursions into his or her jurisdiction by both controlled or uncontrolled aircraft. It is also a means for the controller to complete his mental model for incoming traffic.	This task can result in safety-related airspace information reaching pilots.	Observe aircraft inbound that has not been coordinated and separate those aircraft that are on frequency from the unknown aircraft.
T15 Request pilot and vehicle position reports	Contributes to Safety	Position reports are critical for non-radar separation. Controllers can also use them as a 'crutch,' a reminder to take an action that wasn't feasible before the aircraft report.	This task provides a direct safety benefit for preventing collisions and ensuring separation when a controller uses knowledge of pilot position to separate aircraft.	Confirm location of aircraft that are not observed to be where assigned to be and discover non-conforming aircraft about to enter an active runway. Confirm location of aircraft inbound to ensure that the traffic is actually at the correct (reported) airport.
T17 Project current situation into the future to identify potential threats to safe and efficient flow of air and ground traffic	Contributes to Safety	This task is a direct benefit that can enable a controller to prevent collisions, prevent accidents or recover from an adverse event. The controller is potentially able to identify impending conflicts, violations, or other unsafe situations before the situation is time-critical.		Identify an aircraft taxiing rapidly, project that it may not be able to stop before the hold short bars, and send an arrival around or cancel a takeoff clearance. Project when an arrival can exit a runway to determine if the following arrival needs a go-around clearance to maintain separation. Observe an aircraft begin a turn in a wrong direction, project that if completing the turn it will converge with other traffic and take appropriate action.
A2 - Manage Communications				
S5 Establishing and terminating radio communications				
T28 Establish two-way radio communications	Contributes to Safety	Controllers must establish two-way radio communications to issue clearances and other safety information to the pilot.	This task provides a two-way communication means by which controllers can directly issue instructions to prevent collisions, prevent accidents, and assist with emergency situations.	Without two-way radio communications, the controller can't issue control instructions to an aircraft, meaning conflicts with other aircraft will have to be resolved solely by clearances to the other aircraft. If two-way radio communications have not been established with more than one aircraft, the results could be much more serious.
T29 Issue most current automatic terminal information service (ATIS) information	*Critical to Safety*	Issuing current ATIS information enhances the safety for all aircraft, by providing pertinent information to the cockpit on demand.	This task provides a direct safety benefit to pilots. It informs a pilot of the runways and approaches in use, the weather conditions, and any top-priority NOTAMs.	Issue current ATIS information including runway lengths available, runway restrictions, and braking action to an arrival or departure in time for the crew to prepare or choose an alternate, safer course of action.
S7 Issuing clearances, instructions, or other messages				
T43 Construct clearance, instruction, or message with proper phraseology	*Critical to Safety*	Phraseology described in the ATP (7110.65) and AIM enables the controller to easily convert what the controller wants an aircraft to do into a simple common language that can easily be understood by the pilot and for the pilot to quickly respond clearly and concisely. It also is designed to allow controllers to communicate desires and intentions to each other without misunderstanding	This task is a means by which controllers prevent collisions, prevent accidents, and assist with emergency situations through standardized communication so that meaning is clearly interpreted.	Issue an instruction with proper phraseology (e.g. "go-around" vs. "I would like you to start a climb" when the aircraft wants to land or "continue holding short" vs. "hold short" where the word "continue" may cause confusion).

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T44 Issue clearance, instruction, or message	*Critical to Safety*	Issuing a clearance, instruction, or message is a direct benefit that can enable a controller to prevent accidents and assist with unplanned and emergency situations.	This task is a means by which controllers prevent collisions, prevent accidents, and assist with emergency situations by issuing clearance, instruction, or message to the pilot.	Issue an instruction and message to "go-around, traffic on the runway". Tell another controller to issue an instruction to ensure separation (e.g., "turn him right!" "fly west bound to stay in our airspace").
T46 Verify correct read back	*Critical to Safety*	A correct read back ensures that the controller's instructions have been received and understood by the pilot they were issued to. Ensuring a correct read back is crucial for safety since the controller is solely responsible for incorrect read backs.	This task is a means by which controllers prevent collisions, prevent accidents, and assist with emergency situations by confirming the read back.	The controller issues a taxiway instruction to an aircraft. The pilot begins to read the clearance back when another aircraft checks on the frequency, 'stepping on' the read back and blocking it. The controller doesn't know if the read back is correct and will tell the pilot to repeat the read back to avoid miscommunication.
T47 Restate clearance, instruction, or message if required	*Critical to Safety*	Recognizing that a clearance, instruction, or message was not received, was misunderstood, or caused confusion and then restating or reformulating the clearance, instruction, or message.	This task is a means by which controllers prevent collisions, prevent accidents, and assist with emergency situations by restating essential information to correct a previous misunderstanding.	The ground controller issued a taxi instruction to an aircraft via taxiway Mike. The aircraft read back taxiway Lima. The controller restated the instruction with taxiway Mike since Lima is under construction.
T49 Verify correct read back	*Critical to Safety*	A correct read back ensures that the controller's instructions have been received and understood by the pilot they were issued to. Ensuring a correct read back is crucial for safety since the controller is solely responsible for incorrect read backs.	This task is a means by which controllers prevent collisions, prevent accidents, and assist with emergency situations by confirming the read back.	The controller issues a taxiway instruction to an aircraft. The pilot begins to read the clearance back when another aircraft checks on the frequency, 'stepping on' the read back and blocking it. The controller doesn't know if the read back is correct and will tell the pilot to repeat the read back to avoid miscommunication.
T51 Issue additional clearance, instruction, or messages if required	*Critical to Safety*	Issuing a clearance, instruction, or message is a direct benefit that can enable a controller to prevent accidents and assist with unplanned and emergency situations.	This task is a means by which controllers prevent collisions, prevent accidents, and assist with emergency situations by providing information needed by cockpit whether unknowingly or knowingly.	The controller issues a clarifying clearance, instructions, or information when a pilot appears to be confused or not complying and is about to turn into traffic. The controller issues a message to inform a pilot of a change in circumstance that may impact safety ("gear appears to be up").
A4 - Manage Air Traffic				
S12 Establishing and maintaining positive aircraft or vehicle identification and position				
T80 Observe aircraft or vehicles entering airspace or ground movement areas	*Critical to Safety*	This task can help a controller identify and prevent collisions, near misses, and violations.	ATC serves as an additional set of eyes and ears with an often better perspective than the pilot and provides a more comprehensive understanding of the situation than the pilot alone.	Observe aircraft entering the movement area to be sure that the instructions issued were correct (aircraft is where it was expected to be) and ensure conformance with instructions.
T85 Verify aircraft/vehicle leaving airspace/movement area	*Critical to Safety*	This task is a direct benefit that can enable a controller to prevent collisions, prevent accidents, and assist with emergency situations by confirming if the airspace or movement area is vacated and available for future occupation or not.	ATC serves as an additional set of eyes and ears with an often better perspective than the pilot and provides a more comprehensive understanding of the situation than the pilot alone.	The controller expects a landing aircraft to exit the runway but checks before clearing another aircraft for takeoff from the same runway. The controller realizes the landing aircraft is still on the runway (slow moving, misunderstood instructions, blown tire, etc.) and does not issue takeoff clearance.
S13 Performing visual and radar separation of aircraft and vehicles				
T86 Observe aircraft or vehicles in airspace or on ground movement areas	*Critical to Safety*	This task is a direct benefit that can enable a controller to prevent collisions, prevent accidents, and assist with emergency situations. In order to determine appropriate actions the controller must first be aware of the aircraft or vehicles in airspace or on ground movement areas.		Observe aircraft or vehicles turn in an unexpected direction in order to prevent a runway incursion or loss of separation.
T87 Project mentally an aircraft's or vehicle's trajectory	Contributes to Safety	Projecting vehicles' movements and aircraft trajectories through observation, stated intentions, flight plans, and control instructions are vital to building the mental model the controller uses to anticipate potential conflictions and take preventive measures.		Proactively determine that an aircraft is moving in a direction and speed that will cause a loss of separation. Project that unless aircraft extends its downwind, it will be tied with aircraft on a straight in approach.
T88 Identify potential or actual conflicts	*Critical to Safety*	This task is a direct benefit that can enable a controller to prevent collisions, prevent accidents, and assist with emergency situations by predicting a likely future occurrence before it happens.		Identify aircraft entering airspace with unknown intentions and keep other aircraft at a safe distance. Identify aircraft or vehicles turn in an unexpected direction in order to prevent a runway incursion or loss of separation. Identify traffic overtaking traffic on final approach and issue a "360" or speed adjustment to the following aircraft and ensure separation.
T89 Establish required separation	*Critical to Safety*	The controller's top priority is establishing and maintaining separation. Establishing separation prevents aircraft as well as ground vehicles from coming within dangerously close proximity of each other.	This task enables a controller to prevent collisions and other accidents. This task also ensures aircraft do not violate airspace.	Establish required separation between aircraft (arrivals and departures) by considering multiple pieces of information (aircraft state, airport conditions, visual separation rules, weather, etc.).
T90 Maintain required separation	Contributes to Safety	The controller's top priority is establishing and maintaining separation. Establishing separation prevents aircraft as well as ground vehicles from coming within dangerously close proximity of each other.	This task enables a controller to prevent collisions and other accidents. This task also ensures aircraft do not violate airspace.	Maintain separation and prevent a collision, airspace violation, or wake turbulence encountered through vectors, altitude assignment, speed control and visual separation.
T91 Determine potential control actions	*Critical to Safety*	The controller must determine the control actions needed to maintain separation, prevent accidents, and prevent airspace violations or runway incursions.		Determine control actions that will work in a particular situation to avoid conflict, such as hold position vs. taxi, or go-around vs. landing clearance.
T92 Prioritize control actions	Contributes to Safety	If a controller has multiple aircraft or vehicles requiring control actions, the controller must prioritize the control actions based on the needs and conditions at the time.		Prioritize sending an aircraft around first when on short final; however, prioritize the go-around instructions behind a departure clearance when the aircraft on final is further out and the departure clearance will ensure separation in another situation.

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T93 Issue appropriate control instructions	*Critical to Safety*	The controller must issue the control actions needed to maintain separation, prevent accidents, and prevent airspace violations or runway incursions to the cockpits or vehicles.	This task enables a controller to issue control instructions to the cockpit that are necessary for ensuring separation from other aircraft and airspace.	Issue instruction to go-around in order to avoid traffic that has not yet exited the runway. Aircraft is observed making an unexpected turn toward an active runway, and controller issues instructions to get the aircraft on the right path and away from the active. Ground controller issues instructions that keep an aircraft from blocking a high speed exit off of the runway when that exit is urgently needed for local control traffic.
T94 Verify pilot and vehicle operator conformance to instructions	*Critical to Safety*	The controller must verify that the cockpit or vehicle follow the issued control instructions to maintain separation. If the instructions are not conformed to, the controller must determine and issue additional control instructions.	This task ensures the pilot understood and conformed with control instructions.	Verify instructions are followed (e.g., observe aircraft turn as expected, observe aircraft holding short of a runway, request verbal confirmation of location when not observed).
S14 Performing nonradar procedures for aircraft				
T95 Request current pilot position report	Contributes to Safety	Position reports are critical for non-radar separation. Controllers can also use them as a 'crutch,' a reminder to take an action that wasn't feasible before the aircraft report.	This task provides a direct safety benefit for preventing collisions and ensuring separation when a controller uses knowledge of pilot position to separate aircraft.	Confirm location of aircraft that are not observed to be where assigned to be and discover non conforming aircraft about to enter an active runway. Confirm location of aircraft inbound to ensure that the traffic is actually at the correct (reported) airport.
T98 Issue appropriate control instructions	*Critical to Safety*	The controller must issue the control actions needed to maintain separation, prevent accidents, and prevent airspace violations or runway incursions to the cockpit or vehicles.	This task enables a controller to issue control instructions to the cockpit that are necessary for ensuring separation from other aircraft and airspace.	Issue an altitude that ensures altitude separation from an over flight or opposite direction traffic.
T99 Verify pilot conformance to instructions	*Critical to Safety*	The controller must verify the pilot or vehicle follow the issued control instructions to maintain separation. If the instructions are not conformed to, the controller must determine and issue additional control instructions.	This task ensures the pilot understood and conformed with control instructions.	Verify aircraft altitude ensuring altitude separation from an over flight or opposite direction traffic. Verify aircraft starts departure roll after being cleared for takeoff to ensure separation with traffic landing the same runway.
S15 Responding to special operations				
T100 Receive notice of special operation	Contributes to Safety	In order to respond appropriately to a special operation, the controller must first be aware of it and know the details of the special operation.		Receive notice that an experimental aircraft requires special handling, and keep all aircraft clear of the operation. Receive notice of special law enforcement operations including inflight identification, surveillance, interdiction and pursuit activities that may intrude on traffic pattern or another's airspace, and keep all aircraft clear of the activity.
T101 Evaluate impact of special operation	Contributes to Safety	In order to respond appropriately to a special operation, the controller must evaluate the impact of a special operation on the local operations.		Evaluate the impact to traffic when an experimental aircraft requires special handling, and keep all aircraft clear of the operation (e.g., does runway usage plan need to be changed).
T102 Determine appropriate plan of action	*Critical to Safety*	The controller must determine the appropriate response to and plan of action for the special operation. The plan of action may include determining and issuing control actions in response to the special operation.		Determine action plan when special law enforcement operations including inflight identification, surveillance, interdiction and pursuit activities are in progress that may intrude on traffic pattern or another's airspace and keep all aircraft clear of the activity.
T103 Implement plan of action as required	*Critical to Safety*	The controller must implement the plan of action for the special operation to ensure separation is maintained and airspace is not violated.		Issue instructions to pattern traffic to extend upwind or widen downwind when an experimental aircraft requires special handling.
T104 Re-evaluate plan of action	*Critical to Safety*	If the special operational changes or the plan of action are not sufficient, the controller must re-evaluate the plan of action in response to the special operation to ensure separation is maintained or airspace is not violated.		Re-evaluate instructions to pattern traffic to extend upwind or widen downwind when special law enforcement operations including inflight identification, surveillance, interdiction and pursuit activities may intrude on traffic pattern or another's airspace.
T105 Revise plan of action if required	*Critical to Safety*	The controller must determine the appropriate response to and plan of action for the special operation. The plan of action may include determining and issuing control actions in response to the special operation.		Revise instructions to pattern traffic to extend upwind or widen downwind when an experimental aircraft requires special handling.
T106 Coordinate special operation with others	Contributes to Safety	The controller must coordinate any local special operations with surrounding airspace and airports.		Local controller tells local controller at nearby airport that a helicopter will not be a factor for an arrival. The arrival is informed so that the pilot is not surprised on final which prevents the pilot from over reacting and taking an unexpected action that may create an adverse event.
S17 Monitoring uncontrolled objects/aircraft				
T118 Observe uncontrolled object/aircraft	Contributes to Safety	In order to determine if any action is needed, the controller must first be aware of any uncontrolled objects /aircraft.		Observe a loose animal on the airport and keep aircraft at a safe distance for the animal. Observe an aircraft taxiing on an active runway without a clearance. Observe an aircraft enter the airspace without a clearance or known intentions and keep other aircraft at a safe distance from that aircraft.
T119 Receive information on uncontrolled object/ aircraft	Contributes to Safety	In order to determine if any action is needed, the controller must first be aware of it and know the details of the special operation.		Receive notice of a sighting of an animal or debris on the active runway and send the aircraft on short final around. Receive notice of an aircraft about to violate the airspace boundary and take action to keep other aircraft at a safe distance.
S18 Responding to pilot requests for flight path deviation				
T122 Evaluate pilot request for deviation	Contributes to Safety	Controller evaluates pilot deviation request to ensure separation is maintained while deviating for constraint.	Pilots may request a deviation for weather or turbulence avoidance. This task enables the controller to assist the cockpit in avoiding those constraints.	Evaluate a pilot request to deviate for traffic, weather, descent, flock of birds, and inform pilot regarding how to continue to provide separation.

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T123 Determine alternative clearance if required	*Critical to Safety*	The controller must determine appropriate alternative clearance if the initial request does not maintain separation.	The requested deviation may put the aircraft in conflict with other aircraft or airspace. This task enables the controller to provide the pilot with a deviation clearance that maintains separation.	Aircraft asks to deviate right of course around weather. The controller evaluates the request and determines the deviation will take the aircraft into busy TRACON airspace. The controller explains that a right deviation can't be approved at the moment but can in seven miles. The pilot accepts this solution.
T124 Issue appropriate control instructions if required	*Critical to Safety*	The controller must issue the control instructions needed to maintain separation and satisfy the deviation.	This task enables a controller to issue control instructions to the pilot that are necessary for ensuring separation from other aircraft, airspace, and the deviation constraint.	Issue a direction or altitude to fly to assist the pilot or respond to a pilot request that maintains or enhances safety.
S19 Responding to airborne or ground nonconformance				
T126 Observe aircraft or vehicle nonconformance	*Critical to Safety*	In order to determine appropriate actions in response to a aircraft or vehicle nonconformance, the controller must first be aware of aircraft or vehicle nonconformance.		Observe aircraft turn onto runway instead of taxiway. Observe aircraft turn the wrong way on a taxiway. Observe aircraft not turn to assigned heading after departure.
T127 Receive notice of aircraft or vehicle nonconformance	*Critical to Safety*	In order to determine appropriate actions in response to a aircraft or vehicle nonconformance, the controller must first be aware of it and know the details of the nonconformance.		Receive notice of an aircraft turning onto runway instead of taxiway. Receive notice of an aircraft turning the wrong way on a taxiway. Receive notice of an aircraft not turning to assigned heading after departure.
T128 Inform other controller of nonconformance in that controller's position or sector	Contributes to Safety	The controller must coordinate any nonconformance, as necessary.		Inform controller of an aircraft turning onto runway instead of taxiway. Inform controller of an aircraft turning the wrong way on a taxiway. Inform controller of aircraft flying the wrong way on the downwind.
T129 Query pilot or vehicle operator about intentions	*Critical to Safety*	When the controller identifies an aircraft or vehicle nonconforming, the controller questions the pilot or driver regarding his/her intentions.	The pilot can be informed of the nonconformance and can relay to the controller the pilot's plan.	Query a pilot or vehicle operator to identify intentions and determine what actions are appropriate to prevent collisions, accidents, or assist with an emergency. Ask the pilot if the airplane will clear the runway or evacuate on the runway.
T130 Determine appropriate action to resolve nonconformance	*Critical to Safety*	The controller must determine appropriate control actions for the nonconforming aircraft or vehicle and for other impacted traffic in order to correct the nonconformance, maintain separation, and/or prevent a runway incursion.		An aircraft taxies onto a runway at an intersection rather than the full length that was assigned. In response, the controller issues a corrective clearance.
T131 Issue appropriate control instructions to correct nonconformance	*Critical to Safety*	The controller must issue the control instructions needed to correct the nonconformance.	This task enables a controller to issue control instructions to the pilot that are necessary for correcting the nonconformance while ensuring separation from other aircraft, vehicle, and airspace/runways.	Controller issues a clearance to back taxi or a clearance to cross or exit the active runway.
T132 Issue advisory or alert if required	*Critical to Safety*	If the nonconformance impacts others, the controller must issue a notification of the aircraft or vehicle nonconformance. The nonconformance advisory allows other controllers, aircraft, and vehicles to respond to the nonconformance as needed.	This task allows pilots to have knowledge of the nonconformance situation and to build situation awareness.	Issue traffic alert to traffic about to touch down when an aircraft taxies onto a runway at an intersection down field rather than the full length (behind the arrival) that was assigned.
T133 Verify compliance with instructions	*Critical to Safety*	The controller must verify that the cockpit or vehicle follow the issued control instructions to resolve the nonconformance. If the instructions are not conformed to, the controller must determine and issue additional control instructions.	This task ensures the pilot understood and conformed with control instructions.	Observe aircraft comply with instructions that will provide separation for an aircraft that taxies onto a runway at an intersection rather than the full length that was assigned: take off clearance or a clearance to back taxi, or an instruction to cross or exit the active runway
A5 - Resolve Conflicts				
S20 Performing aircraft conflict resolutions				
T135 Identify potential or actual loss of separation	*Critical to Safety*	In order to determine appropriate actions in response to an aircraft conflict, the controller must first be aware of potential or actual loss of separation.		Identify aircraft not start departure roll as expected, with aircraft on short final to the same runway. Identify aircraft begin to turn opposite to the direction assigned and toward another aircraft.
T136 Receive notice of potential or actual conflict	*Critical to Safety*	In order to determine appropriate actions in response to an aircraft conflict, the controller must first be aware of it and know the details of the potential or actual loss of separation.		Receive information from the TRACON that an unidentified target is entering airspace with and converging with known traffic. Receive notification from ground controller that an aircraft wing tip clearance may interfere with an aircraft taxiing parallel to the departure runway.
T137 Inform other controller of potential or actual conflict in that controller's position or sector	*Critical to Safety*	In order to determine appropriate actions in response to an aircraft conflict, the controller must first be aware of potential or actual loss of separation. Having multiple controllers understand the conflict can help to resolve the situation by utilizing teamwork.		The ground controller informs the local controller of traffic observed departing an intersecting runway where other traffic is departing and converging.
T138 Observe aircraft conflict alert indication	Critical to Safety	In order to determine appropriate actions in response to an aircraft conflict, the controller must first be aware of potential or actual loss of separation. Automation provides a parallel system to assist controllers in identifying a conflict.		Observe low altitude alert of traffic on an instrument approach. Observe a conflict alert indication on converging aircraft.
T140 Determine appropriate action to resolve conflict situation	*Critical to Safety*	The controller must develop various plans of action for responding to and resolving the potential or actual loss of separation.		Determine that instructing an arrival to exit without delay will ensure the runway is clear and resolve the conflict. Determine that giving an aircraft an early warning of opposite direction arrivals to same runway and what instructions to expect, then issue the instructions when appropriate to ensure the runway is clear and resolve the conflict.
T141 Issue appropriate control instructions to ensure separation	*Critical to Safety*	The controller must then communicate the resolution control instructions to all appropriate aircraft in a timely manner.	Pilots are issued control instructions to avoid conflict.	Issuing an immediate turn for converging traffic (turn right immediately for traffic converging) is an appropriate instruction to ensure separation. Issuing a go-around to traffic on final when an aircraft taxies onto the runway without a clearance is an appropriate instruction and will ensure separation.

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T142 Verify pilot conformance with instructions	*Critical to Safety*	The controller must verify that the cockpit follows the issued control instructions to resolve the potential or actual loss of separation. If the instructions are not conformed to, the controller must determine and issue additional control instructions.	This task ensures the pilot understood and conformed with control instructions.	Verify an aircraft has completely exited the runway as instructed. Verify an aircraft is executing a tight turn to avoid traffic. Verify traffic is adding power, climbing, and executing a go around.
T144 Issue advisory or safety/traffic alert as appropriate	*Critical to Safety*	The controller issues traffic alerts to pilots to improve the pilot's situational awareness of the surrounding traffic and to give the reasoning behind the control instruction to further ensure compliance to the instruction.	Improves pilot's situational awareness and gives urgency to instruction. Additionally assists cockpit in developing their own mental model to further understand how to avoid conflict in VFR.	Issuing an immediate turn for converging traffic ("traffic alert, N23P, suggest turn right immediately for traffic converging") is an appropriate instruction to ensure separation. Issuing a traffic alert and an immediate turn instruction to an aircraft on the missed approach converging with a departure is an appropriate safety alert.
T145 Inform pilot when traffic no longer a factor	Contributes to Safety		Closes the feedback loop so that pilot can resume normal operations post conflict.	
S21 Performing unsafe altitude resolutions				
T148 Identify potential or actual unsafe altitude situation	*Critical to Safety*	In order to determine appropriate actions in response to an unsafe altitude situation, the controller must first be aware of potential or actual unsafe altitude.		Identify an aircraft that appears too low on final approach. Identify that an aircraft's reported altitude is below the minimum safe altitude for that area. Identify departing aircraft that are not climbing as expected toward obstructions.
T149 Detect MSAW indication/alarm	*Critical to Safety*	In order to determine appropriate actions in response to an unsafe altitude situation, the controller must first be aware of the MSAW indication/alarm. Automation provides a parallel system to assist controllers in identifying an unsafe altitude.		Detect an MSAW / EMSAW / LAAS automatic read out.
T150 Receive notice of potential or actual unsafe altitude situation	*Critical to Safety*	In order to determine appropriate actions in response to an unsafe altitude situation, the controller must first be aware of potential or actual unsafe altitude.		Receive notice from an aircraft that is operating below the MVA due to icing. Receive notice from supervisor of numerous calls that traffic on final is too low. Receive notice from TRACON of MSAW alert.
T151 Inform other controller of unsafe altitude situation in that controller's position or sector	*Critical to Safety*	In order to determine appropriate actions in response to an unsafe altitude situation, the controller must first be aware of potential or actual unsafe altitude. Having multiple controllers understand the conflict can help to resolve the situation by utilizing teamwork.		Inform appropriate controller when a transmission is heard on emergency frequency from an aircraft that is operating below the MVA due to icing in the airspace. Inform appropriate controller when departing traffic is not climbing as expected.
T153 Determine appropriate action to resolve unsafe altitude situation	*Critical to Safety*	The controller must develop various plans of action for responding to and resolving the potential or actual unsafe altitude.		Determine an alternate route with vectors to correct the unsafe altitude.
T154 Issue appropriate control instructions to resolve unsafe altitude situation	*Critical to Safety*	The controller must then communicate the resolution control instructions to all appropriate aircraft in a timely manner.	Pilots are issued instructions to avoid CFIT.	Issue altitude assignment and instructions to climb. Inform an aircraft to check altitude, suggest a climb, and issue the MVA.
T156 Issue advisory or safety alert as appropriate	*Critical to Safety*	The controller issues safety alerts to pilots to improve the pilot's situational awareness of the surrounding environment and to give the reasoning behind the control instruction to further ensure compliance to the instruction.	Improves pilot's situational awareness and gives urgency to instruction. Additionally assists pilot in developing their own mental model to further understand how to avoid CFIT.	Inform an aircraft to check altitude, suggest a climb, and issue the MVA.
S22 Performing airspace or movement area violation resolutions				
T159 Identify potential or actual airspace or movement area violation	*Critical to Safety*	In order to determine appropriate actions in response to an airspace or movement area violation, the controller must first be aware of potential or actual violation.		Observe an unidentified aircraft in the airspace. Observe an aircraft enter a runway without clearance. Observe an aircraft taxiing at a high rate of speed toward a runway indicating a potential runway incursion about to occur.
T160 Receive notice of potential or actual airspace or movement area violation	*Critical to Safety*	In order to determine appropriate actions in response to an airspace or movement area violation, the controller must first be aware of potential or actual violation and have information regarding the violation.		Receive coordination from the supervisor that an aircraft is about to enter the runway. Receive notice from ground controller that the aircraft has past the hold bars. Receive notice from TRACON of an unidentified target in the tower airspace.
T161 Inform other controller of airspace or movement area violation in that controller's position or sector	*Critical to Safety*	In order to determine appropriate actions in response to an airspace or movement area violation, the controller must first be aware of potential or actual violation. Having multiple controllers understand the conflict can help to resolve the situation by utilizing teamwork.		Inform the nearby tower that traffic appears to be in that class B airspace. Inform local controller that an aircraft is taxiing onto the runway.
T162 Determine validity of airspace or movement area violation				
T163 Determine appropriate action to resolve airspace violation	*Critical to Safety*	The controller must develop various plans of action for responding to and resolving the potential or actual airspace or movement area violation.		Determine if it is best to instruct the arrival to go-around or instruct the violator to taxi off of the runway.
T164 Issue appropriate control instructions to ensure separation	*Critical to Safety*	The controller must then communicate the resolution control instructions to all appropriate aircraft or vehicles in a timely manner.	Pilots are issued instructions to avoid CFIT.	Instruct aircraft to go-around. Instruct aircraft to expect a go-around, traffic on the runway. Instruct aircraft to maintain VFR at or above an altitude to separate that traffic from an airspace intruder. Instruct aircraft to change runways, extend downwind, etc., to separate that traffic from an airspace intruder.
T165 Issue advisory or safety/traffic alert as appropriate	*Critical to Safety*	The controller issues safety alerts to pilots to improve the pilot's or vehicle driver's situational awareness of the surrounding environment and to give the reasoning behind the control instruction to further ensure compliance to the instruction.	Improves pilot's situational awareness and gives urgency to instruction. Additionally assists pilot in developing their own mental model to further understand how to avoid the environment.	Issue a traffic alert to an arrival when an unidentified aircraft appears to be turning, final in close proximity.
S23 Performing vehicle conflict resolutions				

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T167 Observe potential or actual vehicle conflict situation	*Critical to Safety*	In order to determine appropriate actions in response to a vehicle conflict, the controller must first be aware of potential or actual vehicle conflict situation.		Observe an unidentified vehicle on the runway. Observe a vehicle enter a runway without clearance. Observe an vehicle approaching a runway at a high rate of speed indicating a potential runway incursion about to occur.
T168 Receive notice of potential or actual conflict	*Critical to Safety*	In order to determine appropriate actions in response to a vehicle conflict, the controller must first be aware of potential or actual vehicle conflict and have information regarding the situation.		Receive coordination from the supervisor that a vehicle is about to enter the runway. Receive notice from ground controller that the vehicle has passed the hold bars.
T169 Inform other controller of vehicle conflict situation in that controller's position or sector	*Critical to Safety*	In order to determine appropriate actions in response to a vehicle conflict, the controller must first be aware of potential or actual vehicle conflict situation. Having multiple controllers understand the conflict can help to resolve the situation by utilizing teamwork.		Inform local controller that a vehicle is proceeding onto the runway.
T171 Determine appropriate action to resolve vehicle conflict situation	*Critical to Safety*	The controller must develop various plans of action for responding to and resolving the potential or actual vehicle conflict situation.		Determine whether to instruct aircraft to go-around for a vehicle on the runway, instruct aircraft to expect a go-around, vehicles on the runway, or instruct aircraft to change runways, extend downwind, etc., to separate that traffic from the vehicle on the runway. Instruct vehicle to exit runway.
T172 Issue appropriate control instructions to ensure separation	*Critical to Safety*	The controller must then communicate the resolution control instructions to all appropriate aircraft in a timely manner.	Pilots are issued control instructions to avoid conflict with vehicle.	Instruct aircraft to go-around for a vehicle on the runway. Instruct aircraft to expect a go-around, vehicles on the runway. Instruct aircraft to change runways, extend downwind, etc., to separate that traffic from the vehicle on the runway. Instruct vehicle to exit the runway immediately.
T173 Verify conformance with instructions	*Critical to Safety*	The controller must verify that the vehicle and impacted aircraft follow the issued control instructions to resolve the potential or actual vehicle conflict. If the instructions are not conformed to, the controller must determine and issue additional control instructions.	This task ensures the pilot understood and conformed with control instructions.	Verify vehicle is exiting the runway as instructed. Verify the aircraft is executing a go-around as instructed.
T175 Issue advisory or traffic alert as appropriate	*Critical to Safety*	The controller issues safety alerts to pilots to improve the pilot's or vehicle driver's situational awareness of the surrounding environment and to give the reasoning behind the control instruction to further ensure compliance to the instruction.	Improves pilot's situational awareness and gives urgency to instruction. Additionally assists pilot in developing their own mental model to further understand how to avoid the violation.	Issue an advisory to the vehicle (e.g. "Stop, traffic touching down on the runway")
T176 Inform others when traffic is no longer a factor	*Contributes to Safety*		Closes the feedback loop so that pilot can resume normal operations post conflict.	
S24 Issuing unsafe condition advisories				
T179 Determine need for advisory or alert	*Critical to Safety*	The controller identifies a potential unsafe situation requiring a safety advisory or alert.		Determine to alert aircraft that the previous arrival is now disabled on the runway and send aircraft around.
T180 Generate advisory or alert appropriate for situation	*Critical to Safety*	The controller must develop various plans of action for responding to and resolving the unsafe conditions.		Considering required phraseology, determine the alert is appropriate, (e.g. state "disabled aircraft on runway" and send aircraft around).
T181 Issue advisory or alert	*Critical to Safety*	The controller must then communicate the resolution control instructions to all appropriate aircraft in a timely manner.	Pilots are issued control instructions to avoid the unsafe condition.	State "disabled aircraft on runway" and send aircraft around.
T182 Monitor response to advisory or alert	*Critical to Safety*	The controller must verify that all aircraft or vehicle issued the safety advisory or alert conform to the advisory or alert to avoid the unsafe condition.	This task ensures the pilot understood and conformed with control instructions.	After receiving and issuing a traffic alert to an aircraft including instructions to avoid the traffic, local controller monitors aircraft response to ensure that instructions are followed, resulting in separation maintained or increasing. If necessary, the local controller reissues or amends the instruction to ensure separation.
A6 - Manage Departing and Arriving Traffic				
S25 Managing ground departure traffic				
T190 Issue taxi instructions	*Critical to Safety*	Ground controller issues taxi instructions avoiding crossing active runway without coordination. Ground controllers issue taxi instructions for avoiding other traffic.	Issued taxi instructions to avoid collisions and runway incursions.	Issue taxi instructions that include all necessary hold short instructions. Issue taxi instructions that will ensure an aircraft completely clears the runway for traffic landing. Issue taxi instructions that give priority to emergency response vehicles and emergency aircraft.
T197 Ensure taxi conformance with issued instructions	*Critical to Safety*	The controller must verify that the pilot follows the issued control instructions to ensure active runways are not crossed. If the instructions are not conformed to, the controller must determine and issue additional control instructions.	This task ensures the pilot understood and conformed with control instructions.	Tell an aircraft to "Stop" when observed approaching a runway without instructions to enter the runway. Ensure an aircraft is at a speed that indicates it will follow instructions to pass behind emergency vehicles or an emergency aircraft inbound. Ensure aircraft follows instructions and does not taxi in an area where there is no wing tip clearance for the particular size of aircraft.
S26 Issuing takeoff information and instructions				
T201 Determine appropriate interval for departure	*Critical to Safety*	The local controller must determine the appropriate departure intervals for same runway, wake turbulence, and intersecting or parallel runways to ensure separation is maintained.	This task ensures the pilot avoids collisions and wake turbulence.	Determine when to clear an aircraft for takeoff when an aircraft is landing on an intersecting runway, or departing ahead from the same runway.
T202 Request release for departure	*Critical to Safety*	Normally this is a standard operation. However, if an aircraft departs without a release, then a controller can prevent an adverse event, possibly an airspace violation, by requesting a release before the aircraft leaves tower airspace.	This task ensures the pilot avoids collisions.	Request release for a departing aircraft if the aircraft has been departed by local controller without one.
T208 Scan runway environment to ensure conditions are safe for takeoff	*Critical to Safety*	Scanning the runway surface for possible safety hazards (foreign object debris, loose animals, pedestrians, vehicles, or aircraft) has a direct impact on safety of operations. This task is a direct benefit that can enable a controller to prevent collisions, prevent accidents, and assist with emergency situations.	This task ensures the pilot avoids collisions and prevents accidents.	Scan runway and note that the previous arrival is now disabled on the runway; send aircraft around and alert emergency responders. Scan runway and observe a deer crossing and cancel takeoff clearance. Scan runway and observe a preceding arrival has not yet exited.
S27 Managing aircraft takeoff terminations				

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T216 Determine need to cancel takeoff clearance	*Critical to Safety*	In response to an adverse situation, the local controller must determine the need to cancel the takeoff clearance for an aircraft in order to prevent a collision or accident.	ATC serves as an additional set of eyes and ears with an often better perspective than the cockpit and provides a more comprehensive understanding of the situation than the pilot alone.	Determine the need to cancel takeoff clearance when an unsafe condition exists (e.g., previous arrival is still on the runway, a runway incursion is occurring, or an animal is loose on the runway).
T217 Receive pilot notification of aborted takeoff	*Critical to Safety*	In response to an adverse situation, the pilot will initiate an aborted takeoff and will notify the controller of the aborted takeoff. The controller must respond as necessary to the aborted takeoff.	This task informs the controller of situation so that he/she can issue separation instructions to aircraft.	Receive notice of aborted takeoff and respond by issuing instructions that will separate aircraft (e.g., send aircraft on final around).
T218 Observe aborted takeoff	*Critical to Safety*	The controller must observe the aborted takeoff to determine the appropriate and timely response to the aborted takeoff.		Observe an aborted takeoff and respond by issuing instructions that will separate aircraft (e.g., send aircraft on final around).
T219 Issue takeoff cancellation	*Critical to Safety*	When the controller is aware of a situation that may impact the safety of the departure (separation or otherwise), a takeoff clearance is cancelled.	This task enables a controller to issue takeoff cancellation to an aircraft to avoid an adverse situation.	Cancel takeoff clearance when an unsafe condition exists (e.g., previous arrival is still on the runway, a runway incursion is occurring, or an animal is loose on the runway,).
T220 Coordinate takeoff termination with others as appropriate	*Critical to Safety*	The controller must coordinate a terminated takeoff with other impacted controllers.		Coordinate with local controller to stop an aircraft from departing when an aircraft is observed taxiing across an active runway without a clearance.
S28 Managing airborne departures				
T224 Receive notice of missed approach/go around	*Critical to Safety*	In order to determine appropriate actions and ensure separation, the controller must first be aware of a missed approach/go around.		Receive notice of a missed approach and turn the aircraft that just departed the same runway to establish separation. Receive notice of a missed approach and cancel takeoff clearance from an intersecting runway.
T225 Inform departure controller of missed approach/go around	*Critical to Safety*	As part of the response to a missed approach/go around, the controller must inform the departure controller to maintain separation.	Direct safety benefit for avoiding collisions by informing controller of situation so that he/she can issue separation instructions to aircraft.	Inform departure controller of a missed approach and coordinate a heading necessary to establish separation. Inform departure controller of a missed approach and coordinate actions to assist in an emergency.
S29 Managing arrivals				
T228 Observe arriving aircraft	*Critical to Safety*	In order to determine appropriate actions for arrival traffic, the controller must first be aware of arriving aircraft.		Observe unidentified aircraft enter airspace and provide traffic advisories and safety alerts to other aircraft in the airspace.
T233 Verify pilot has current arrival information	*Critical to Safety*		This task provides a direct safety benefit to pilots. It informs a pilot of the runways and approaches in use, the weather conditions, and any top-priority NOTAMs.	
T234 Issue current arrival information as necessary	*Critical to Safety*		This task provides a direct safety benefit to pilots. It informs a pilot of the runways and approaches in use, the weather conditions, and any top-priority NOTAMs.	
T235 Issue appropriate traffic information	*Critical to Safety*	When traffic is issued to the aircraft, the crew can assist in providing separation and understanding the importance of conformance to clearance.	This task helps to improve the pilot's situational awareness.	Issue traffic to follow, intersecting runway traffic, departure traffic, maneuvering traffic, and any other traffic that the aircraft may consider a factor. Local controller issues inbound helicopter traffic to a VFR arrival where paths will converge and ensures separation.
T236 Issue arrival instructions	*Critical to Safety*	Issuing specific arrival instructions provides a sequence to arrival aircraft that will ensure separation.	This task provides a direct safety benefit to pilots by providing arrival instructions that ensure separation and avoid wake turbulence.	Issue traffic pattern entry instructions and landing clearance based on ensuring separation with other aircraft. Cancel landing clearance when a vehicle unexpectedly enters the runway. Reissue landing clearance when the runway is clear.
T237 Evaluate airfield and traffic conditions for safe operations	*Critical to Safety*	In order to determine appropriate actions for arrival traffic, the controller must first evaluate the airfield and traffic conditions for safe operations.		Evaluate the runway status by getting clear of runway reports from vehicles that were previously cleared onto the runway. Observe a runway incursion and evaluate the impact on the next arrival. Observe FOD on the runway and evaluate whether to let aircraft land or issue a go around.
T238 Determine landing sequence	*Critical to Safety*	Specific priorities are considered by the controllers in determining a landing sequence and in order to determine appropriate actions, the controller must first determine what the landing sequence will be.	This task provides a direct safety benefit to pilots by providing arrival instructions that ensure separation and avoid wake turbulence.	Determining to sequence an aircraft low on fuel ahead of slower traffic that is unfamiliar with operations at the field.
T239 Coordinate landing sequence with another controller if necessary	*Critical to Safety*	The controller must coordinate the landing sequence with other impacted controllers, as necessary.		Coordinate with approach control that an aircraft low on fuel needs to be sequenced ahead of slower traffic that is unfamiliar with operations at the field.
T240 Formulate a clearance with appropriate control instructions	*Critical to Safety*	In order to issue a landing clearance, the controller must first formulate a clearance with appropriate control instructions (e.g., land and hold short, plan to exit a first high speed, number to follow traffic, etc.).		Instruct aircraft to exit runway without delay and reason. Instruct aircraft to land and hold short of the intersecting runway for arriving traffic.
T241 Issue landing/option clearance	*Critical to Safety*	Issuing the landing clearance when appropriate will assist the crew in preparing appropriately for landing and avoiding any confusion and unexpected actions by traffic on final.	This task enables a controller to issue takeoff cancellation to an aircraft to ensure separation and avoid wake turbulence.	Issue landing/option clearance to aircraft when separation is anticipated to exist between arrivals and departures.
A8 - Assess the Impact of Weather				
S36 Processing weather information				
T295 Observe changed weather conditions	*Critical to Safety*	Weather conditions have a direct impact on aircraft operation. In order to determine appropriate actions and what weather information aircraft may need, the controller must first be aware of changed weather conditions		Observe weather conditions that will prohibit the use of visual separation between departures so that another type of separation can be applied and separation is ensured.
T296 Observe record of changed weather conditions	*Critical to Safety*	Weather conditions have a direct impact on aircraft operation. In order to determine appropriate actions and what weather information aircraft may need, the controller must first be aware of changed weather conditions		Obtain weather report on weather conditions.
T298 Request weather reports				

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T299 Request braking action report	*Critical to Safety*		Controller query pilots on breaking action to obtain more information on airport weather conditions.	Ice is present on the runway and the pilot reports poor braking conditions.
T300 Determine whether runway or airport conditions have changed	*Critical to Safety*	In order to determine appropriate actions in response to changing weather conditions, the controller must first be aware of if the runway or airport conditions have changed.		Determine when weather conditions have changed and will prohibit the use of visual separation between departures so that another type of separation can be applied and separation is ensured. Determine when runway conditions may cause an aircraft to roll long (icing and standing water) so that separation can be increased on final between arrivals or to time a departure between arrivals.
T301 Determine whether control zone is IFR or VFR	*Critical to Safety*	In order to determine appropriate actions in response to changing weather conditions, the controller must first be aware of if conditions are IFR or VFR.		Determine when a field is about to be or has become IFR to prevent pilots that are VFR qualified from operating in the airspace and potentially becoming disoriented.
T304 Update automatic terminal information system (ATIS) message to reflect new weather information	*Critical to Safety*		This task provides a direct safety benefit to pilots. It informs a pilot of the runways and approaches in use, the weather conditions, and any top-priority NOTAMs.	Pilot checks the current ATIS report to obtain new weather information.
T305 Inform others of changed airport conditions	*Critical to Safety*	Informing other controllers, pilots, vehicle drivers, and others of changed airport conditions enable individuals to be aware of changed weather conditions.	This task assist pilots to successfully deal with environmental conditions.	Inform pilots when braking action deteriorates (adjusting speed on final in anticipation may prevent lack of control on the runway). Inform VFR pilots that are maneuvering in the airspace when IFR conditions are developing so that they may choose to land or depart the area in order to fly in conditions they are qualified for.
S37 Responding to severe weather information				
T306 Observe severe weather intensity and trend	*Critical to Safety*	Current weather (particularly thunderstorm activity, turbulence, wind sheer and strong winds) impacts aircraft and can cause unsafe situations. Unexpected turbulence or wind sheer encountered on final approach, especially in close proximity to the ground, may cause an unsafe situation.		Observe movement of a thunderstorm toward the airport in order to evaluate the potential impact to operations and aircraft.
T307 Observe display or record of updated severe weather data	*Critical to Safety*	Severe weather conditions have a direct impact on aircraft operation. In order to determine appropriate actions and what weather information aircraft may need, the controller must first be aware of severe weather conditions		Controller sees updated weather radar display which indicates thunderstorms approaching.
T309 Evaluate severe weather information to identify potential impact	*Critical to Safety*	In order to respond to severe weather, controllers need to evaluate the impact of severe weather on current airport operations and the weather's impact of airport operations and traffic.		Evaluate movement of a thunderstorm toward the airport and identify impacted aircraft that need to be notified to avoid the area (aircraft planning to depart in that direction or arriving and flying through that area).
T313 Disseminate severe weather or airport environmental information to others	*Critical to Safety*	Informing other controllers, pilots, vehicle drivers, and others of severe weather conditions improves those individuals' situational awareness.	This task helps assist pilots to successfully deal with environmental conditions.	Notify crew of wind sheer location and intensity.
A9 - Manage Airspace and Movement Areas				
S38 Requesting temporary release of airspace or movement areas				
T315 Determine need for temporary release of airspace or movement area under other control	Contributes to Safety	There may be times when it enhances safety for another controller to take over airspace or a movement area. This determination is based upon input/information from multiple sources (e.g., coordination, visual or verbal cues, equipment/automation).		An aircraft seems to be having problems tracking the final approach on the ILS and/or maintaining appropriate altitudes for the approach. It may enhance safety to give the tower's airspace to the approach controller to work the aircraft and clear the aircraft for landing.
T316 Request temporary release/use of airspace or movement area	Contributes to Safety	There may be times when it enhances safety for another controller to take over airspace or a movement area. This determination is based upon input/information from multiple sources (e.g., coordination, visual or verbal cues, equipment/automation).		Local controller requests TRACON airspace to keep a missed approach, low on fuel, in the pattern for a visual approach.
T318 Issue appropriate control instructions	*Critical to Safety*	The issuance of the appropriate control instruction allows aircraft to avoid airspace violations while maintaining separation.	This task is a means by which controllers prevent airspace violations by aircraft.	Ground controller issues instructions that keep an aircraft from blocking a high speed exit off of the runway when that exit is urgently needed for local control traffic.
S39 Responding to requests for temporary release of airspace or movement areas				
T321 Receive request for temporary use of airspace or movement area	Contributes to Safety	There may be times when it enhances safety for another controller to take over airspace or a movement area. This determination is based upon input/information from multiple sources.		Receive request to release airspace to the TRACON for an emergency aircraft inbound being vectored using the EOVM.
T323 Evaluate feasibility of releasing airspace or movement area temporarily	Contributes to Safety	There may be times when it enhances safety for another controller to take over airspace or a movement area. This determination is based upon input/information from multiple sources.		Evaluate the impact and safety of releasing airspace to the TRACON for an emergency aircraft inbound being vectored using the EOVM.
T324 Release airspace with conditions as appropriate	Contributes to Safety	When appropriate, the controller will release the airspace or movement area with conditions.		Release airspace to the TRACON for an emergency aircraft inbound being vectored using the EOVM.
T325 Issue appropriate control instructions	*Critical to Safety*	The issuance of the appropriate control instruction allows aircraft to avoid airspace violations while maintaining separation.	This task is a means by which controllers prevent collisions and prevent accidents.	Issue control instructions required to operate safely in the released airspace and avoid traffic (e.g., Traffic is a Cessna maneuvering VFR North of the field at 3000, remain E, SE of the airport).
S40 Responding to changes in airspace or movement area				
T328 Receive notice of change in status of airspace or movement area	Contributes to Safety	In order for controllers to respond to airspace or movement area status, controllers must first be aware of any status changes.		Local controller hears the ground controller state that the aircraft that was crossing the runway is now disabled on the runway.
T329 Coordinate change in status of airspace or movement area with others	Contributes to Safety	In order for controllers to respond to airspace or movement area status, controllers must first be aware of any status changes.		Ground controller advises local control that the aircraft that was crossing the runway is now disabled on the runway.

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T330 Coordinate airspace or movement area restrictions with others	*Critical to Safety*	There are times when a movement area becomes unexpectedly unavailable; coordination with others enhances safety and may prevent an accident.	This task allows pilots to have an improved situational awareness.	An arriving aircraft becomes disabled on a runway and local control immediately informs approach control, allowing approach control the time to change other arrivals to a different runway or airport in a safe, orderly fashion without going into a holding pattern waiting for a cancellation from the disabled aircraft.
T332 Determine appropriate actions to ensure separation from airspace or movement area	*Critical to Safety*	There is often more than one possible action to take with an aircraft that is affected by a change in airspace or movement area status, for example: go-around, side step, circle, or change runway assignment. Determining which response is the most appropriate to enhance safety or recover from an adverse event may be based on input/information from multiple sources.		Local control is informed the runway is temporarily unavailable to other traffic due to a disoriented pilot on the runway or FOD. Local control determines that the arriving aircraft should be issued a go-around.
T333 Issue appropriate control instructions	*Critical to Safety*	The controller must issue the control instructions to the appropriate aircraft and vehicle in response to the airspace or movement area status.	This task enables controllers to issue pilots control instructions in response to a change in status of a movement area or airspace.	Local controller issues a go around in response to a closed runway.
S41 Responding to changes in runway or taxiway usage or conditions				
T338 Receive notice of changes to runway or taxiway usage or conditions	Contributes to Safety	In order to determine appropriate actions, the controller must first be aware of changes to runway or taxiway usage or conditions.		Receive notice of nil braking action on the runway and distribute the information.
T340 Coordinate change in runway or taxiway usage or conditions with others	*Critical to Safety*	There are times when a movement area becomes unexpectedly unavailable; coordination with others enhances safety and may prevent an accident.		Coordinate a poor braking action report with local control in order for the local controller to plan extra spacing between arrivals and avoid go-arounds or loss of separation. Coordinate a nil braking action report to stop LAHSO operations.
T342 Determine appropriate action to accommodate changes in runway or taxiway usage or conditions	*Critical to Safety*	The controller must determine the appropriate response to and plan of action in response to the change in runway or taxiway conditions.		Determine to cancel landing clearance and send aircraft around when lined up for an intersecting runway and LAHSO operations are no longer available due to braking action.
T343 Issue appropriate control instructions	*Critical to Safety*	The controller must issue the control instructions to the appropriate aircraft and vehicle in response to the runway or taxiway conditions.	This task enables controllers to issue pilots control instructions in response to a change in runway or taxiway conditions.	Issue instruction to cancel landing clearance and send aircraft around when lined up for an intersecting runway and LAHSO operations are no longer available due to braking action.
A11 - Respond to Emergencies and Unusual Situations				
S46 Responding to emergencies				
T366 Receive notice of emergency	*Critical to Safety*	In order to respond to an emergency, the controller must first be aware of an emergency and have information regarding the emergency.		Receive notice of an aircraft inbound without operational gear. Receive notice of a hijacked aircraft inbound with unknown intentions. Receive notice of a disabled aircraft on the runway.
T367 Detect an emergency	*Critical to Safety*	In order to respond to an emergency, the controller must first be aware of an emergency and have information regarding the emergency.		Observe an aircraft on short final with flames around the engines. Observe an aircraft veer off of the runway due to ice. Observe an aircraft blow a tire on takeoff. Observe an aircraft land with gear up.
T368 Evaluate the situation	*Critical to Safety*	In order to respond to an emergency, the controller must evaluate the nature of the emergency.		Evaluate the assistance that is required for the aircraft. Evaluate whether action needs to be taken with other aircraft.
T369 Determine appropriate plan of action	*Critical to Safety*	The controller must determine the appropriate plan of action for responding to an emergency.		Determine actions that will assist the aircraft, such as a longer runway, a fly by to check gear, holding away from the airport to assess the situation, issuing instructions to other aircraft or vehicles to keep the aircraft separated.
T370 Respond to emergency as required	*Critical to Safety*	The controller must respond to the emergency by implementing the plan of action and issuing necessary control actions.	Pilots are issued control instructions to avoid and respond to an emergency.	Assign the aircraft the runway requested. Check the gear on a fly by. Provide information about known areas where landing away from the airport may be feasible.
T371 Review emergency checklist				
T372 Declare emergency if necessary	*Critical to Safety*	If necessary, the controller must declare an emergency for aircraft as needed.	This task ensures the pilot avoids collisions and prevents accidents.	Declaring an emergency allows the aircraft priority handling and emergency response equipment.
T373 Amend traffic flow and sequence to expedite emergency aircraft	*Critical to Safety*	If needed, the controller must amend the traffic flow and sequence to aid the emergency aircraft.	This task ensures the pilot avoids collisions and prevents accidents in response to an aircraft emergency.	Amend the traffic pattern to a different runway. Amend the traffic pattern direction to allow aircraft to proceed direct.
T374 Coordinate emergency information with others	*Critical to Safety*	The controller must coordinate an aircraft emergency with other impacted controllers, pilots, vehicles, and others.	This task ensures other pilots in the area are aware of the aircraft emergency.	Coordinate the expeditious response of emergency vehicles to an accident scene and ensure they receive priority.
T375 Re-evaluate plan of action	*Critical to Safety*	The controller must re-evaluate the appropriate plan of action for responding to an emergency.		Re-evaluate the plan as things progress, e.g., aircraft is unable to land the first time therefore it is now appropriate to land pattern traffic as the emergency aircraft maneuvers for another attempt.
T376 Revise plan of action if required	*Critical to Safety*	The controller must revise and implement the appropriate plan of action for responding to an emergency.		Re-evaluate the plan as things progress, e.g., aircraft is unable to land the first time therefore it is now appropriate to land pattern traffic as the emergency aircraft maneuvers for another attempt.
S47 Responding to unusual situations				
T378 Detect unusual situation	*Critical to Safety*	In order to respond to an unusual situation, the controller must first be aware of the unusual situation and have information regarding the unusual situation.		Detect an aircraft turning unexpectedly toward another aircraft. Detect an aircraft that has been cleared for take off but not beginning take off roll when expected.
T379 Receive notice of unusual situation	*Critical to Safety*	In order to respond to an unusual situation, the controller must first be aware of the unusual situation and have information regarding the unusual situation.		Receive notice that the gear is not down on an aircraft short final. Receive notice that the aircraft rolling did not have an IFR release as needed.
T380 Evaluate situation	*Critical to Safety*	In order to respond to an unusual situation, the controller must evaluate the nature of an unusual situation.		Evaluate separation and options when an aircraft turned unexpectedly toward another aircraft. Evaluate separation and options when an aircraft that has been cleared for take off is not beginning take off roll when expected.

Appendix D: Safety-Critical Tasks Assessment

Activity (A-bold), *Sub-Activity (S-italics),* Task (T)	Safety Criticality	Safety-Critical Benefit Description - Air Traffic	Safety-Critical Benefit Description - Cockpit	Example(s)
T382 Determine appropriate plan of action	*Critical to Safety*	The controller must determine the appropriate plan of action for responding to an unusual situation.		Determine best option when an aircraft that has been cleared for take off is not beginning take off roll when expected. Determine best option when the aircraft rolling did not have an IFR release as needed.
T383 Issue required security notifications immediately, if necessary	*Critical to Safety*	The controller must issue security notifications to necessary individuals to make them aware of the unusual situation.	This task prevents accidents and reduces the negative consequences when a negative situation occurs.	Notify aircraft of security threat and remote parking.
T384 Comply with security notifications and/or coordination as required	*Critical to Safety*	The controller must comply with a security notification and coordinate with others to prevent collisions, prevent accidents, and assist with unplanned and emergency situations.		Comply with airport operations notification to send threatened aircraft to remote parking.
T385 Implement plan of action	*Critical to Safety*	The controller must respond to the unusual situation by implementing the plan of action and issuing necessary control actions.	Pilots are issued control instructions to avoid and respond to an emergency.	Implement chosen option when an aircraft that has been cleared for take off is not beginning take off roll when expected. Implement chosen option when the aircraft rolling did not have an IFR release as needed.
T386 Re-evaluate situation	*Critical to Safety*	The controller must re-evaluate the appropriate plan of action for responding to an unusual situation.		Evaluate developing situation after implementing chosen option when an aircraft that has been cleared for take off is not beginning take off roll when expected.
T387 Revise plan if appropriate	*Critical to Safety*	The controller must revise and implement the appropriate plan of action for responding to an unusual situation.		Revise the plan if necessary to increase separation.
T388 Implement revised plan	*Critical to Safety*	The controller must respond to the unusual situation by implementing the plan of action and issuing necessary control actions.	Pilots are issued control instructions to avoid and respond to an emergency.	Implement revised plan if necessary to increase separation (e.g., issue instructions to the other aircraft involved, give a further heading to keep aircraft turning away from traffic, establish visual separation between aircraft).
T389 Coordinate information with others as appropriate	*Critical to Safety*	The controller must coordinate an unusual situation with other impacted controllers, pilots, vehicles, and others.	This task ensures other pilots in the area are aware of the unusual situation.	Coordinate with local controller that smoke and flames were observed on the aircraft. Coordinate that an aircraft appears to be lost and may enter an active runway.
S48 Responding to system/equipment degradation or failure				
T390 Detect degradation or failure	*Critical to Safety*	In order to respond to a system or equipment degradation or failure, the controller must first be aware of the degradation or failure and have information regarding the degradation or failure.		Local controller detects failure of ILS while traffic is in IMC executing the approach, notifies the aircraft that the ILS appears to be inoperable and issues missed approach instructions.
T391 Receive notice degradation or failure	*Critical to Safety*	In order to respond to a system or equipment degradation or failure, the controller must first be aware of the degradation or failure and have information regarding the degradation or failure.		Local controller observes that the runway lights are no longer working at night, advises the aircraft of the failure, and issues a land at own risk clearance or missed approach instructions.
T392 Coordinate degradation or failure information with others	*Critical to Safety*	The controller must coordinate the degradation or failure with other impacted controllers, pilots, vehicles, and others.	This task ensures other pilots in the area are aware of the degradation or failure.	Local controller coordinates with TRACON that the runway lights of the primary instrument runway are not operating at night and the coordination is accomplished to change the configuration to lit runway.
T393 Initiate backup system if appropriate	*Critical to Safety*	When a controller initiates a backup system appropriately, the consequences of degradation or failure of equipment can be minimized and action can be taken to maintain safety and/or recover from the failure.		Ground controller realizes that aircraft on frequency are not hearing ground control transmissions and changes to backup transmitter before safety is compromised.
T394 Implement backup procedures	*Critical to Safety*	When a controller initiates backup procedures appropriately, the consequences of degradation or failure of equipment can be minimized and action can be taken to maintain safety and/or recover from the failure.		As the tower is evacuated, controllers initiate use of backup hand-held radios to ensure safety and/or recovery from the evacuation.
T396 Coordinate with others regarding repair if required	Contributes to Safety	When a controller coordinates with others regarding the repairs of degradation or failure of equipment, it can be addressed in a timely manner and assist in recovery from the event.		Local controller coordinates with technicians by demonstrating the degradation or failure of equipment for technicians to trouble shoot and address the problem appropriately.

APPENDIX E: OVERALL AIRTRACS AND SJA TASK FINDINGS FOR THE TOWERED AIRPORT ASSESSMENT

SJA Benefit Assessment Findings

Activity	Sub-Activity	Percentage of Classified ATSAP Reports
A1- Establish Situation Awareness	S02-Assessing position data	32.08%
A2-Manage Communications	S05- Establishing and terminating radio communications	6.60%
	S07- Entering flight plan data	24.53%
A4-Manage Air Traffic	S12- Performing visual and radar separation of aircraft and vehicles	2.83%
	S13- Performing nonradar procedures for aircraft	8.49%
	S19- Performing aircraft conflict resolutions	4.72%
A5- Resolve Conflicts	S20- Performing unsafe altitude resolutions	37.74%
	S21- Performing airspace or movement area violation resolutions	2.83%
	S22- Performing vehicle conflict resolutions	40.57%
	S23- Issuing unsafe condition advisories	12.26%
	S24- Managing ground departure traffic	0.94%
A6- Manage Departing and Arriving Traffic	S25- Issuing takeoff information and instructions	1.89%
	S27- Managing airborne departures	1.89%
	S29- Responding to flow constraints	11.32%
A9-Manage Airspace and Movement Areas	S38- Responding to requests for temporary release of airspace or movement areas	0.94%
	S39- Responding to changes in airspace or movement area status	0.94%
	S41- Transferring position/sector for reconfiguration	0.94%
A10- Manage Resources	S44- Supporting teamwork environment	0.94%
A11- Respond to Emergencies and Unusual Situations	S46- Responding to unusual situations	10.38%
	S47- Responding to system/equipment degradation or failure	9.43%

Note: Only those sub-activities and activities that were classified are shown.

AirTracs Operator Context

Operator Context Factors	Percentage of Classified ATSAP Reports	
	Adverse	Positive
Physical Environment	--	--
Technological Environment	**6.60%**	
Communication Equipment	1.89%	
Display / Interface	0.94%	
Software / Automation	1.89%	
Warnings / Alerts	0.94%	
Other Technological Environment	0.94%	
Airport Conditions	**57.55%**	**0.94%**
Combined Positions	9.43%	0.94%
Ground Vehicle Traffic	6.60%	
Aircraft Traffic	10.38%	
Airport Weather	7.55%	
Visibility / IMC	3.77%	
Wind	3.77%	
Signage / Lighting / Markings	8.49%	
Construction	4.72%	
Layout / Design	1.89%	
Runway Complexity	6.60%	
Other Airport Condition	1.89%	
Airspace Conditions	**3.77%**	
Sector Traffic	1.89%	
Restricted Airspace	1.89%	
Sector Weather / Turbulence	1.89%	
Aircraft Actions	**100.00%**	
Deviation	62.26%	
Procedures	5.66%	
ATC Instructions / Clearance	58.49%	
Unexpected Aircraft Performance	25.47%	
Aircraft Equipment / System Operation	1.89%	
Responding to Abnormal Situation	6.60%	
Other Aircraft Actions	1.89%	
Communication	**36.79%**	**1.89%**
Controller-Cockpit Communication	26.42%	
Readback / Hearback	7.55%	
Phraseology / Call Sign	7.55%	
Information / Clearance	5.66%	
Frequency Congestion	0.94%	
Responsiveness	7.55%	
Controller-Controller Communication	5.66%	
Handoff / Point-Out	0.94%	
Aircraft Information	3.77%	1.89%
Other ATC-ATC Communication	0.94%	
Other Communication	1.89%	
Cognitive / Physiological	**6.60%**	
Workload	0.94%	
High Workload	1.89%	
Expectation Bias	3.77%	
Knowledge/Experience	**22.64%**	
On-the-Job Training/Developmental	12.26%	
Trainer Intervention	0.94%	
CPC Experience	0.94%	
Unfamiliar Task/Procedure	7.55%	
Other Knowledge/Experience	0.94%	

Note: Only those factors that were classified are shown.

AirTracs Facility, Agency, and Outside Influences

Facility Influences Factors	Percentage of Classified ATSAP Reports	
	Adverse	Positive
Supervisory Planning	**4.72%**	--
Facility Procedures		
SOPs	0.94%	
LOAs	2.835	
Equipment Readiness	0.94%	
Supervisory Operations	**4.72%**	**1.89%**
Position Combination	0.94%	
Controller Assignment	0.94%	
Oversight / Assistance	1.89%	1.89%
Sector / Airport Configuration	0.94%	
Position Combination	0.94%	
Traffic Management Unit	--	--

Note: Only those factors that were classified are shown.

Agency Influences Factors	Percentage of Classified ATSAP Reports	
	Adverse	Positive
Resource Management	**0.94%**	
Equipment / Facility Resources	0.94%	
Agency Climate	--	--
Operational Process	--	--

Note: Only those factors that were classified are shown.

Outside Influences Factors	Percentage of Classified ATSAP Reports	
	Adverse	Positive
Outside Influences	**0.94%**	
Other Outside Influences	0.94%	

Note: Only those factors that were classified are shown.

Outcome Analysis

Outcome Category	Outcome Description	Percentage of Classified ATSAP Reports
A	Controller issued traffic advisory or alerts to provide separation or sequencing	25%
B	Controller cleared / prevented a runway incursion – no traffic conflict	23%
C	Controller cleared / prevented a runway incursion –traffic conflict / go-around	33%
D	Controller assisted the pilot in avoiding closed runway, shortened runway, construction, surface hazard, TFRs, or other NOTAM issues.	4%
E	Controller assisted in an aircraft emergency / unusual situation	14%
F	Controller corrected an aircraft's altitude or course	4%
G	Controller provided safety-related weather information	4%
H	Controller prevented / resolved airspace violation	9%

Severity Analysis

Severity	Percentage of Classified ATSAP Report
No Safety Effect	8%
Near Runway Incursion	6%
Runway Incursion	45%
Near Airspace Violation	1%
Airspace Violation	7%
Near Conflict	16%
Conflict	18%

Outcome	Description	Severity						
		No Safety Event	Near Runway Incursion	Runway Incursion	Near Airspace Violation	Airspace Violation	Near Conflict	Conflict
A	Controller issued traffic advisory or alerts to provide separation or sequencing	3	0	4	0	1	10	8
B	Controller cleared / prevented a runway incursion – no traffic conflict	1	3	20	0	0	0	0
C	Controller cleared / prevented a runway incursion – traffic conflict / go-around	0	2	29	0	0	1	3
D	Controller assisted the pilot in avoiding closed runway, shortened runway, construction, surface hazard, TFRs, or other NOTAM issues.	0	0	1	0	1	1	1
E	Controller assisted in an aircraft emergency / unusual situation	3	0	0	0	0	2	10
F	Controller corrected an aircraft's altitude or course	0	1	0	0	1	1	1
G	Controller provided safety-related weather information	1	0	0	0	0	1	2
H	Controller prevented / resolved airspace violation	1	0	0	1	6	0	2

APPENDIX F: OVERALL MODIFIED AIRTRACS AND SJA TASK FINDINGS FOR THE NON-TOWERED AIRPORT ASSESSMENT

SJA Benefit Assessment: Potential Controller Prevention

Prevention Activity	Prevention Sub-Activity	Percentage of Classified ASRS Reports
A1- Establish Situation Awareness	S01- Assuming position responsibility	13.64%
	S02-Assessing position data	84.09%
	S03- Monitoring equipment and automation system status	4.55%
A2- Manage Communications	S05- Establishing and terminating radio communications	52.27%
	S07- Entering flight plan data	88.64%
A4-Manage Air Traffic	S12- Performing visual and radar separation of aircraft and vehicles	63.64%
	S13- Performing nonradar procedures for aircraft	59.09%
	S14- Responding to special operations	61.36%
	S15- Processing requests for VFR flight following	2.27%
	S16- Monitoring uncontrolled objects/aircraft	6.82%
	S17- Responding to pilot requests for flight path deviation	38.64%
	S19- Performing aircraft conflict resolutions	18.18%
A5- Resolve Conflicts	S20- Performing unsafe altitude resolutions	4.55%
	S22- Performing vehicle conflict resolutions	2.27%
	S24- Managing ground departure traffic	9.09%
A6- Manage Departing And Arriving Traffic	S25- Issuing takeoff information and instructions	13.64%
	S26- Managing aircraft takeoff terminations	27.27%
	S27- Managing airborne departures	25.00%
	S28- Managing arrivals	13.64%
	S29- Responding to flow constraints	63.64%
A8- Assess the Impact of Weather	S36- Responding to severe weather information	2.27%
A9-Manage Airspace and Movement Areas	S39- Responding to changes in airspace or movement area status	4.55%
	S40- Responding to changes in runway or taxiway usage or conditions	6.82%
	S41- Transferring position/sector for reconfiguration	4.55%
A11- Respond to Emergencies and Unusual Situations	S48- Responding to system/equipment degradation or failure	2.27%

Note: Only those sub-activities and activities that were classified are shown.

SJA Benefit Assessment: Potential Controller Recovery

Recovery Activity	Recovery Sub-Activity	Percentage of Classified ASRS Reports
A1- Establish Situation Awareness	S02-Assessing position data	9.09%
	S03- Monitoring equipment and automation system status	2.27%
A2- Manage Communications	S05- Establishing and terminating radio communications	15.91%
	S07- Entering flight plan data	38.64%
A4-Manage Air Traffic	S12- Performing visual and radar separation of aircraft and vehicles	2.27%
	S17- Responding to pilot requests for flight path deviation	4.55%
	S19- Performing aircraft conflict resolutions	9.09%
A5- Resolve Conflicts	S20- Performing unsafe altitude resolutions	75.00%
	S21- Performing airspace or movement area violation resolutions	2.27%
	S22- Performing vehicle conflict resolutions	43.18%
	S23- Issuing unsafe condition advisories	2.27%
	S24- Managing ground departure traffic	2.27%
A6- Manage Departing And Arriving Traffic	S26- Managing aircraft takeoff terminations	6.82%
	S27- Managing airborne departures	2.27%
	S28- Managing arrivals	9.09%
	S29- Responding to flow constraints	18.18%
A7- Transfer of Aircraft Identification	S32- Accepting handoffs	2.27%
A11- Respond to Emergencies and Unusual Situations	S46- Responding to emergencies	9.09%
	S47- Responding to unusual situations	9.09%
	S48- Responding to system/equipment degradation or failure	2.27%

Note: Only those sub-activities and activities that were classified are shown.

Modified AirTracs Operator Acts

Modified Operator Act Factors	Percentage of Classified ASRS Reports Adverse
Aircraft Errors	**75.00%**
Unaware of Aircraft Traffic Location	50.00%
Lined Up on Unexpected Runway	2.27%
Gear-Up Landing	2.27%
Unexpected Turn	31.82%
Aircraft Traffic Sequence	29.55%
Missed Approach Execution	2.27%
Pilot Technique - Breaking	9.09%
Unaware of Airport / Airspace Information	9.09%
Other Aircraft Error	6.82%

Note: Only those factors that were classified are shown.

Modified AirTracs Operator Context

Modified Operator Context Factors	Percentage of Classified ASRS Reports Adverse
Physical Environment	**4.55%**
Vision Restriction	4.55%
Technological Environment	**--**
Airport Conditions	**29.55%**
Aircraft Traffic	2.27%
Airport Weather	15.91%
Visibility / IMC	13.64%
Wind	2.27%
Signage / Lighting / Markings	13.64%
Construction	4.55%
Airspace Conditions	**4.55%**
Sector Traffic	2.27%
Restricted Airspace	2.27%
Other Airspace Condition	2.27%
Aircraft Actions	**18.18%**
Deviation	2.27%
Procedures	2.27%
Unexpected Aircraft Performance	11.36%
Aircraft Equipment / System Operation	13.64%
Flight Planning	2.27%
TCAS RA Response	2.27%

Modified Operator Context Factors	Percentage of Classified ASRS Reports Adverse
Other Aircraft Actions	2.27%
Communication	**70.45%**
Cockpit-Cockpit Communication	61.36%
Location / Intent of Other Aircraft	36.36%
Phraseology	6.82%
Wrong Frequency	9.09%
Responsiveness	22.73%
Cognitive / Physiological	**22.73%**
Working Memory / Distraction	9.09%
Complacency / Vigilance	2.27%
Expectation Bias	6.82%
Fatigue	2.27%
Rushed / Time Pressure	6.82%
Other Cognitive / Physiological Factor	2.27%
Knowledge/Experience	**6.82%**
Unfamiliar Task/Procedure	6.82%

Note: Only those factors that were classified are shown.

Modified AirTracs Facility, Agency, and Outside Influences

Modified Facility Influences Factors	Percentage of Classified ASRS Reports Adverse
Supervisory Planning	**2.27%**
Other Supervisory Planning	2.27%
Supervisory Operations	--
Traffic Management Unit	--

Modified Agency Influences Factors	Percentage of Classified ASRS Reports Adverse
Resource Management	--
Agency Climate	--
Operational Process	**2.27%**
Response to Event / Report	2.27%

Modified Outside Influences	Percentage of

Factors	Classified ASRS Reports
	Adverse
Outside Influences	**4.55%**
Military Influences	2.27%
Other Outside Influences	2.27%

Note: Only those factors that were classified are shown.

Outcome Analysis

Outcome Category	Outcome Description	Percentage of Classified ASRS Reports
A	Controller issued traffic advisory or alerts to provide separation or sequencing	70%
B	Controller cleared / prevented a runway incursion – no traffic conflict	9%
C	Controller cleared / prevented a runway incursion –traffic conflict / go-around	16%
D	Controller assisted the pilot in avoiding closed runway, shortened runway, construction, surface hazard, TFRs, or other NOTAM issues.	5%
E	Controller assisted in an aircraft emergency / unusual situation	11%
F	Controller corrected an aircraft's altitude or course	2%
G	Controller provided safety-related weather information	2%
H	Controller prevented / resolved airspace violation	2%

Severity Analysis

Severity	Percentage of Classified ASRS Report
No Safety Effect	5%
Near Runway Incursion	2%
Runway Incursion	16%
Near Airspace Violation	--
Airspace Violation	--
Near Conflict	59%
Conflict	18%

Outcome and Severity Analysis

Outcome	Description	Severity						
		No Safety Event	Near Runway Incursion	Runway Incursion	Near Airspace Violation	Airspace Violation	Near Conflict	Conflict
A	Controller issued traffic advisory or alerts to provide separation or sequencing	2	0	1	0	0	21	7
B	Controller cleared / prevented a runway incursion – no traffic conflict	0	0	4	0	0	0	0
C	Controller cleared / prevented a runway incursion – traffic conflict / go-around	0	1	3	0	0	3	0
D	Controller assisted the pilot in avoiding closed runway, shortened runway, construction, surface hazard, TFRs, or other NOTAM issues.	1	0	0	0	0	1	0
E	Controller assisted in an aircraft emergency / unusual situation	0	0	1	0	0	2	2
F	Controller corrected an aircraft's altitude or course	0	0	0	0	0	1	0
G	Controller provided safety-related weather information	0	0	0	0	0	0	1
H	Controller prevented / resolved airspace violation	0	0	0	0	0	1	0

APPENDIX G: ASSESSMENT OF NTSB FATAL REPORTS

NTSB REPORTS CHI07FA140A

Causal and Contributory Factors

- Visual Scan: "The inadequate visual lookout of the pilots in both airplanes, and their failure to maintain clearance from each other's airplane."
- Vision Restriction: Cessna (high wing) climbing aircraft and Beech Bonanza (low wing) descending aircraft. "The radar showed that airplane descending and returning to ISZ. The radar showed another airplane departing ISZ to the north about 1500. The second airplane was climbing. The radar data showed that about 1502, the airplanes' radar returns came together."
- Training: "…certified flight instructor (CFI) and dual student aboard the Cessna."

ATCT Controller Prevention Tasks

- Manage Communications: Issuing clearances, instructions, or other messages
- Manage Air Traffic: Performing visual and non-radar separation of aircraft and vehicles
- Manage Departing and Arriving Traffic: 1) Issuing takeoff information and instructions and 2) Managing arrivals

ATCT Controller Recovery Tasks

- Resolve Conflicts: Performing aircraft conflict resolutions

NTSB REPORT ANC04FA016A

Causal and Contributory Factors

- Special Use Airspace: Glider Aerobatic box active in close proximity to RWY 5L "…an aerobatic box, which was adjacent to runway 5L at an uncontrolled airport. The aerobatic box measured 1 kilometer square, and extended from the surface up to 6,600 feet msl (5000' agl). The southern boundary of the aerobatic box was located about 1,490 feet north of runway 5L's centerline. "
- Airspace Violation: "… a Piper J3C airplane…made a left downwind turn into the area where the glider was performing the aerobatic maneuvers."
- Visual Scan: "The inadequate visual lookout by the pilots of both aircraft, which resulted in their failure to see-and-avoid each other's aircraft and a subsequent midair collision."
- Flight Planning / Airspace Awareness: "…the airplane [pilot failed] to determine that the aerobatic box was in use by the glider prior to his entry into the aerobatic box." "When the aerobatic box is active, the Prescott FSS issues a notice to airmen (NOTAM) concerning the status of the aerobatic box… There was no record of either pilot of the Piper having requested NOTAM information, or receiving a preflight weather briefing on the day of the accident."
- Experience: "According to the pilot's logbook, his total aeronautical experience consisted of about 819.8 hours, with no flight activity being recorded between August 30, 1998 and December 13, 2003, or 15 days before the accident."
- Airspace Design: Aerobatic box was abnormally low. "The Turf Soaring School utilizes the aerobatic box for training and exhibition of aerobatic gliders. In addition, the certificate of waiver allows Turf Flying School to conduct aerobatics below 1,500 feet agl, which is otherwise

prohibited under FAR 91.303 (e). The aerobatic box is marked on the desert floor by a series of bright white panels that are readily visible while airborne."

Observed/Possible Contributory Factors

- Conflicting Airport Information: Airport Facility Directory was not in agreement with segmented circle. "According to the southwestern airport facilities directory, aircraft departing from runway 5L, the same runway that was used by the departing Piper, are instructed to fly a right-hand traffic pattern. However, during the IIC's review of an aerial photograph of the Pleasant Valley Airport dated September 30, 2003, it was discovered that the airport's segmented circle, located in the center of the airport, adjacent to the intersection of runways 5L and 23, depicts a left-hand traffic pattern when departing from runway 5L. "
- Radio Equipment: "Neither of the aircraft involved in the accident had a radio, nor were they required to."
- Medical Certification: "… the airplane owner did not possess a current airman's medical certificate."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Performing nonradar procedures for aircraft, 4) Responding to special operations, 5) Monitoring uncontrolled objects/aircraft, and 6) Responding to pilot requests for flight following
- Resolve Conflicts: Performing airspace or movement area violation resolutions
- Manage Departing and Arriving Traffic: 1) Managing ground departure traffic and 2) Issuing takeoff information and instructions
- Manage Airspace and Movement Areas: 1) Responding to requests for temporary release of airspace or movement areas, 2) Responding to changes in airspace or movement area status, and 3) Responding to changes in runway or taxiway usage or conditions

NTSB Report ERA09LA124

Causal and Contributory Factors

- Violation: VFR into IMC. VFR qualified pilot in an aircraft not equipped for instrument flight decides to depart in IFR/IMC weather conditions "
- Low Experience: Pilot not IFR rated "The pilot's flight logbook showed he logged a total of 113 hours at the time of the accident."
- Weather: Airport was reported IMC with low ceilings and reduced visibility (fog, night).

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position and 2) Responding to airborne or ground nonconformance

- Resolve Conflicts: Performing airspace or movement area violation resolutions -- identify movement area violation in the event that aircraft taxied out for departure without a clearance
- Manage Departing and Arriving Traffic: Managing ground departure traffic
- Assess the Impact of Weather: 1) Processing weather information and 2) Responding to severe weather information

NTSB REPORT ERA09LA302A

Causal and Contributory Factors

- Flight Planning: "Prior to takeoff from DCU, the pilots did not preplan any formation flying."
- Communication of Location/Intent of Other Aircraft: – RV-8 pilot did not communicate distance information to CJ-6A pilot. "…the pilot of the RV-8 radioed that he was at the CJ-6A's 6 o'clock position. He then radioed that he was at the CJ-6A's 4'oclock position."
- Violation: RV08 pilot proceeded with formation flight without confirmation from CJ-6A pilot or flight planning of formation flight. (FAR91-111) "…the witness heard a transmission over CTAF from the RV-8 pilot, 'form fly, okay?' There was no reply from the CJ-6A pilot. "
- Unknown/Unexpected Aircraft Maneuvering: Pilot of the CJ-6A was unaware of exact location of the RV-8 aircraft when performing right climbing turn "

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Performing nonradar procedures for aircraft, 4) Responding to special operations, 5) Responding to pilot requests for flight path deviation, and 6) Responding to airborne or ground nonconformance
- Manage Departing and Arriving Traffic: Managing arrivals
- Respond to Emergencies and Unusual Situations: Responding to unusual situation
- Resolve conflicts: Performing aircraft conflict resolutions

NTSB REPORT ERA10FA029

Causal and Contributory Factors

- Restricted Visibility: "Night visual meteorological conditions prevailed at the time."
- Insufficient Procedure: Airport Directory procedure for runway 13 did not protect for terrain. Terrain west and southwest would have indicated left traffic would be safer.
- Airport/Airspace Conditions Communication: Did not communicate complete information of traffic pattern safety regulation.
- Unaware of Airport Information: Flying low at night with mountains surrounding. "On the final pattern, the airplane was observed on downwind leg, at low altitude, and in level flight. The witnesses stated that the engine was running normally, followed by the sound of an impact, then silence." "The flight instructor reported that most people familiar with Morse State Airport just call 'Bennington traffic' and he commented to his student that the pilot 'must have been a stranger to the area.'"

- Experience: Unfamiliar airport at night with low numbers of night flying hours. "He had logged 11.2 hours in the previous 12 months, including 2.4 hours of night time. His total logged night time was 15.8 hours and his last recorded night time was on September 21, 2009, when 4 night landings were logged. A review of his logbook did not reveal any evidence that he had previously flown patterns or landings at DDH."

Observed / Possible Contributory Factors

- Pilot confused runways: Possible pilot disorientation of location or possible misspeak 31 vs. 13. "Morse State Airport, Cessna (did not get his call sign) maneuvering to enter a right downwind for runway 31."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Performing nonradar procedures for aircraft,
- Resolve Conflicts: 1) Performing unsafe altitude resolutions and 2) Issuing unsafe condition advisories

NTSB Report ERA10FA180A

Causal and Contributory Factors

- Visual Scan: "The pilots of both airplanes did not maintain an adequate visual lookout to see and avoid each other."

Observed/Possible Contributory Factors

- Vision Restriction: Restricted visibility of low wing descending. "The PA-32 was a … low wing airplane" "The RV-6 was an unpainted low-wing." "

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Manage Departing and Arriving Traffic: Managing arrivals
- Resolve Conflicts: Performing aircraft conflict resolutions

NTSB Report ERA11FA101A

Causal and Contributory Factors

- Unknown/Unexpected Aircraft Maneuver - "Interpolation of radar data revealed that the accident airplane departed from the same airport about 21 minutes prior to the accident and completed a right downwind departure, contrary to the established left traffic pattern."

- Vision Restriction: Aircraft under helicopter. "…the airplane remained below the helicopter pilot's field of view as the helicopter overtook the airplane from behind and descended upon it from above." Helicopter above a high-wing aircraft. "Because of the high-wing structure of the airplane, and its relative position and altitude, the helicopter's image was either blocked from the airplane pilot's view by the left wing, or was above and behind the airplane in the seconds before collision." Vision restriction due to lack of contrast, size of windscreen, lack of movement, and angle of the sun.
- Visual Scan: Incomplete Scan – 1) Helicopter "Although the data indicated that the airplane would likely have been visible to the pilot of the helicopter." "During the descent, about 500 feet above ground level, the pilot 'saw about 2 feet of white wing right outside.' He 'pulled power' and then felt the contact." 2) Airplane "In a written statement he provided along with photographs, one witness described the airplane as it approached the airport on the west side of the runway, and the helicopter's descent until the two aircraft collided."
- Technology Warning/Alerts: Device did not warn of the Cessna – Technology limitations. "…the onboard traffic avoidance system (TAS) did not provide the pilot with any alert of its presence because the system operated on line-of-sight principles.
- Communication: Location and intentions of Cessna are unannounced and unknown. "Further, no radio position reports from the accident airplane were confirmed." "He added that he distinctly recalled 3 separate position reports from the helicopter as it approached SHD, and standard traffic calls from airplanes in left traffic at SHD. He did not recall hearing a radio call that announced a non-standard entry…"
- Expectation Bias: Helicopter pilot familiarity with customary routes and aircraft not in that location. "In addition, the helicopter pilot's familiarity with the customary routes used by fixed-wing pilots to fly into and out of the airport also made detection of the airplane less likely, because the airplane was not in a location that normally contained conflicting traffic." "The witnesses were familiar with the airport, and with what they described as the usual traffic pattern of aircraft around the airport."
- Duty-Related Distraction: Scan was reduced. "Finally, before the helicopter turned and overtook the airplane, the helicopter pilot's visual attention would have likely been directed toward the landing area, which would also have limited opportunities for detection of the airplane."
- Aircraft Deviation from Procedure: Non-standard entry to the airport traffic pattern "The airplane proceeded north of the airport before reversing course and returning to approach the airport from the northeast." "The airplane's departure and arrival were contrary to published Federal Aviation Administration guidance, the airplane owner's guidance, and the airplane pilot's guidance to his own students with regard to pattern entry at the destination airport." "
- Airport/Airspace Congestion: Unusually busy aircraft traffic. "All of the pilots stated that the traffic pattern at SHD was 'unusually busy' around the time of the accident."
- Communication- Frequency congestion: Frequency was crowded due to unusually busy aircraft traffic. "…the frequency was crowded on the day of the accident."

Observed / Possible Contributory Factors

- Delayed Activation of Transponder: The transponder was not on and may explain not being observed on TCAD. "The airplane's transponder appeared to be off for about 3 minutes after takeoff before transmitting the visual flight rules transponder code (1200) for the remainder of

the observed flight; the transponder appeared to be on and functioning at the time of the collision."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: Performing aircraft conflict resolutions
- Manage Departing and Arriving Traffic: 1) Issuing takeoff information and and 2) Managing arrivals

NTSB REPORT LAX03FA066A

Causal and Contributory Factors

- Special Use Airspace/Special Operations: Airshow "On the day of the accident, Parker Airport, also known as Avi Suquilla, was hosting an 'Air Expo' and there were over 4,000 people in attendance."
- Incomplete NOTAM information: The Airshow NOTAM by the Airport Authority was nonexistent.
- Unaware of airport/airspace information: "Cessna not involved in the unannounced 'air expo' special operations…" "…the transient Cessna was departing on runway 19 with a left climbing turnout northbound on the downwind leg, destined for Lake Havasu City."
- Visual Scan: 1) Cessna made incomplete scan and 2) Grumman made incomplete scan. "…about midfield, while straight and level on the downwind leg, the pilot started the Before Landing Check List. During that procedure he checked his position relative the runway. At that instant, another aircraft came into view from below and ahead of him and the collision occurred. "
- Duty Related Distraction: Checklist
- Communication: Unknown location and intention of the Cessna. Cessna did not announce location and intention OR was announcing on an incorrect frequency. "The Unicom operator did not recall hearing the Cessna on frequency. "
- Aircraft on Wrong Radio Frequency: Correct frequency was not dialed into the Cessna's radio, aircraft were on two different frequencies (differed by .025).

Observed/Possible Contributory Factors

- Possible Vision Restriction: High wing/ low wing combination may have put planes in the blindspot of one another. Cessna was a high wing and Grumman F6F-5 was a low wing.

ATCT Controller Prevention Tasks

- Manage Communications: Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and positions, 2) Performing visual and radar separation of aircraft and vehicles, 3) Monitoring uncontrolled objects/aircraft, and 4) Responding to airborne or ground nonconformance
- Resolve Conflicts: Performing aircraft conflict resolutions

- Manage Departing and Arriving Traffic: 1) Issuing takeoff information and instructions and 2) Managing arrivals

NTSB REPORT LAX04LA106

Causal and Contributory Factors

- Unknown/Unexpected Aircraft Maneuver: Aircraft would not expect a helicopter to descend directly in front of it – practicing autorotation.
- Communication: Although both aircraft transmitted position and intentions, the information was incomplete which contributed to using an improper sequence for use of the runway. The pilot did not hear the location and intentions of other aircraft. There is no indication that the helicopter heard any transmissions from aircraft operating at Compton airport.
- Visual Scan: Neither aircraft visually observed the other in time to prevent collision. "He further stated that he never saw or heard the Thorpe. "

Observed/Possible Contributory Factors

- Unintentional Deviation from Procedure: Helicopter did not give right of way to lower aircraft per 14 CFR 91. No reason to believe the helicopter saw the aircraft.

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Performing visual and radar separation of aircraft and vehicles and 2) Performing nonradar procedures for aircraft
- Resolve Conflicts: Performing aircraft conflict resolutions
- Manage Departing and Arriving Traffic: Manage arrivals

NTSB REPORT LAX06FA054

Causal and Contributory Factors

- Flight Planning: Pilot decided to depart VFR without a flight plan and descend into destination airport when fog, low ceiling, and other obscurations impacted destination. Pilot would have been aware of the likelihood of IMC conditions at the destination airport.
- Weather: IMC – Low visibility and ceilings, "winds were calm; visibility less than 1/4 mile; skies 100 feet overcast; temperature 7 degrees Celsius; dew point 6 degrees Celsius; altimeter 30.22 inHg."

Observed/Possible Contributory Factors

- Knowledge/Experience Limitations: Pilot was limited to VFR flight in this multiengine aircraft. "A review of FAA airman records revealed that the pilot held a commercial pilot certificate with ratings for airplane single engine land, instrument airplane, and private pilot airplane multiengine land limited to VFR only."

ATCT Controller Prevention Tasks

- Managing Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages

- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and positions, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: Issuing unsafe conditions advisories
- Managing Departing and Arriving Traffic: Managing arrivals
- Assess the Impact of Weather: Processing weather information
- Resolve Conflicts: 1) Performing unsafe altitude resolutions and 2) Performing airspace or movement area violation resolutions

NTSB REPORT LAX08FA049A

Causal and Contributory Factors

- Aircraft Error: Procedures Violated –Pilot flew too low for the established traffic pattern. "…the Cessna 150M pilot turned onto the crosswind leg prior to reaching 700 feet above ground level, which is contrary to the Federal Aviation Administration's recommended procedures."
- Vision Restriction: Due to turn, the banked wing blocked view of traffic. "…was likely not able to see it in the final 9 seconds prior to the collision as the Cessna 150 was turning left onto the downwind leg."
- Visual Scan: Insufficient scan by pilots of both aircraft. "As the Cessna 172N's pilot was approaching the airport, the Cessna 150M, which was travelling at 74 knots (ground speed), would have been in his view at the 10:30 to 11:00 o'clock position and low in the windscreen." "Neither airplane appeared to change course, rock their wings, or commence an avoidance maneuver prior to colliding."
- Communication: Neither aircraft announced intentions and location. "None of the pilots reported to the Safety Board investigator having heard either of the accident pilots broadcast their respective airplane registration numbers along with their intentions."

Observed/Possible Contributory Factors

- Possible Vision Restriction: "The Safety Board investigator was not able to ascertain whether the pilot who occupied the right seat was acting as a safety pilot, pilot-in-command, or had any flying responsibilities. The airplane was equipped with dual flight controls, which were reported as being functional. The airplane could be flown by either pilot from either seat."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and positions, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: Performing aircraft conflict resolutions
- Managing Departing and Arriving Traffic: 1) Issuing takeoff information and instructions and 2) Managing arrivals

NTSB Report MIA03FA068

Causal and Contributory Factors

- Flight Planning: Pilot decided to depart VFR without a flight plan when fog, low ceiling, and obscuration impacted area.
- Weather: Fog reduced visibility
- Reduced Visibility: Instrument Meteorological conditions
- Weather information: Discrepancy between observed weather and closest reported weather possibly led pilot to believe he would on top of the clouds quickly.

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and positions, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Manage Departing and Arriving Traffic: Managing ground departure
- Assess the Impact of Weather: Processing weather information
- Resolve Conflicts: 1) Performing airspace or movement area violation resolutions and 2) Performing unsafe altitude resolutions

NTSB Report MIA03LA088A

Causal and Contributory Factors

- Airport/Airspace Congestion: There was high traffic volume. "…there were 8 agricultural airplanes operating from the airport."
- Airport Design: Runway lacks parallel taxiway resulting in arrivals taxiing on the runway after landing. "The east/west oriented runway does not have a parallel taxiway but there is a taxiway that runs north/south which intersects the runway."
- Communication: Locations and intentions of other aircraft are unknown. "There was no record that either pilot used the business radio to transmit takeoff or landing intentions. "
- Visibility Restriction: Sun glare reduced ability of departing aircraft to see arrival. "…reduction of visibility of the pilot-in-command of N6037H due to sun glare during takeoff…"
- Opposite Direction Landing: Aircraft lined up on unexpected runway. Wind favored use of runway 9, but departure aircraft used runway 9 while the arrival aircraft used runway 27 and was taxiing on the runway. "…the poor in-flight planning by the pilot-in-command of N7318K, for his intentional landing downwind." "…wind was from 130 degrees at 10 knots…"
- Visual Scan: Departing aircraft made incomplete scan of aircraft location. Departure may not have been looking for traffic that was just touching down on the runway in the opposite direction and may have instead been concentrating on the final approaches. This would be exacerbated by the sun glare restriction to visibility.

Observed/Possible Contributory Factors

- NORDO: Both aircraft were flying without radio communication equipment.

- Communication: The pilots decided to not utilize the available "business radio" to announce location and intentions. They had an atypical radio, but did not use it to announce their location and intentions. Further details are unknown.

ATCT Controller Prevention Tasks

- Manage Communications: Issuing clearance, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Monitoring uncontrolled objects/aircraft, and 4) Responding to airborne or ground nonconformance
- Resolve Conflicts: 1) Performing aircraft conflict resolutions and 2) Performing airspace or movement area violation resolutions
- Manage Departing and Arriving Traffic: 1) Managing ground departure traffic, 2) Issuing takeoff information and instructions, and 3) Managing arrivals

NTSB Report MIA04FA043A

Causal and Contributory Factors

- Visual Scan: Incomplete scan by both 1) Piper and 2) Cessna aircraft. 1) "He looked to the right and saw an airplane coming at us, which was so close he did not have time to react before the collision." 2) "He reported that the right wheel of the Cessna airplane hit the right wing of the airplane he was in. "
- Communication: Cessna did not report location (namely altitude) or intentions. "The same individual who personally knows the pilot of the Cessna airplane, reported hearing him report crossing midfield at KCLW; the Cessna pilot did not report altitude or intention. The individual did not hear any other radio calls from the Cessna pilot."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and positions, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: Performing aircraft conflict resolutions
- Manage Departing and Arriving Traffic: Manage Arrivals

NTSB Report MIA06FA022A

Causal and Contributory Factors

- Aircraft Maintenance/ Violation: The Pilot chose to fly with a known equipment problem of no landing lights at night. "The position lights and taxi light of the EC 130 B4 helicopter were on at the time of impact; the landing light was previously burned out. " "Examination of the cockpit of the EC 130 B4 helicopter revealed the taxi light switch on the pilot's collective control was in the on position, while the landing light switch was in the off position. " "One individual who knows the pilots of both helicopters and who was located at the Miami International Airport reported that on the day of the accident at approximately 2000 hours, the EC 130 B4 helicopter arrived to do a 'quick drop' but they never saw the flight arrive. At the time, a big floodlight was

operating but they still could see helicopters when they were 8 miles out. After touchdown the pilot flew straight towards his position and landed. He walked to the helicopter and noticed the landing light was not on. He helped offload the passengers and advised the pilot to turn on the landing light. The pilot replied, 'oh, sorry about that thanks man.' The helicopter departed but the landing light was not illuminated."

- Visibility Restriction: The landing light was inoperable. "…the intentional operation of the EC 130 B4 helicopter by the pilot with known deficiencies in equipment (inoperative landing light)…"
- Communication: The location and intentions of EC 130 helicopter were unknown. "The pilot of the AS-350B helicopter reportedly never heard communications from the pilot of the EC 130 B4 helicopter" "He further reported he does not recall hearing 'a radio transmission from the other aircraft involved in the accident.'" "…though he (the individual providing VFR advisory service) did not recall hearing the EC 130 B4 pilot provide a position report on initial contact. "
- Visual Scan: The AS-350B made an incomplete scan of aircraft location. "… he did not see the other helicopter before the collision. "
- Visual Detection: VFR Advisory service provider was only able to see one helicopter. "He (individual providing VFR advisory service) stated that he had visual contact with the AS-350B helicopter, but he never had visual contact by landing or strobe light with the EC 130 B4 helicopter, which was on a straight-in approach landing to the east. " "He did not see the EC 130 B4 helicopter until it was descending to the ground, nor did he recall seeing any lights from it. "
- Visual Perception: VFR Advisor mistook the position of the helicopter. "His impression was that the EC 130 B4 helicopter was 'farther away.' "
- Reduced Visibility: The view of the VFR Advisor was obscured by 1) dust and smoke and 2) distracting police lights.
- Aircraft Approach: Pilots of AS-350B did not follow approach procedure. "A factor in the accident was the failure of the AS-350B pilot to follow approach procedures suggested in the Speedway Heliport Operations Manual." "The witnesses reported the AS-350B helicopter was slightly higher and to the right of the EC 130 B4 helicopter, and the AS-350B helicopter appeared to be flying at a faster speed than the EC 130 B4 helicopter. One witness reported that the AS-350B helicopter was 'coming in hard' with respect to speed and vertical descent rate, while another witness reported that the AS-350B helicopter overtook the EC 130 B4 helicopter, and appeared to be flying at twice the speed of the EC 130 B4 helicopter."
- Heliport Authority: The Speedway Heliport personnel failed in multiple areas. "Findings in the investigation were …failure of Speedway Heliport personnel to: 1) conduct a safety briefing in advance of the race, 2) flight test temporary lighting to see whether any issues exist, and 3) require a single point entry and reporting point for approach to the heliport."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Performing nonradar procedures for aircraft, and 4) Responding to airborne or ground nonconformance
- Resolve Conflicts: Performing aircraft conflict resolutions

- Manage Departing and Arriving Traffic: Managing arrivals

NTSB Report MIA08FA070A

Causal and Contributory Factors

- Sequencing/Separation Error: Pilot decides to land on an occupied runway. "Witnesses recalled hearing the Velocity announce its intentions for a straight in approach to runway 15; he arrived on final just behind the 4th RV-8, and according to the witnesses he was too close to the 4th RV-8 to land as a separate airplane. "
- Unplanned/Unexpected Aircraft Maneuver: The Velocity aircraft at full engine power exited the runway to the left into the grass and struck the aircraft that had exited onto the grass. "The lead RV-8, N128RV had entered the intersection and was midway between runway 15 and the parallel taxiway when it was struck from the left side by the Velocity." "The Velocity continued in the grass and witnesses stated that they observed the Velocity collide with the RV-8 while in a left turn and with full engine power." "Both mains remained in the grass until impact with the RV8. Braking action was noted from the left main gear at 2,310 feet and the nose gear was observed in the grass at 2,331 feet and the right main gear braking action was noted at 2,367. The impact point with the RV 8 was measured at 2,391 feet from the arrival end of runway 15."
- Performance Differences between Aircraft: The 300-hp Velocity was significantly more powerful than the 180-hp RV-8. Combination allows for easy overtake of less powerful aircraft operating in shared airport.

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: 1) Performing aircraft conflict resolutions and 2) Performing airspace or movement area violation resolutions
- Manage Departing and Arriving Traffic: Managing arrivals

NTSB Report MIA08FA144

Causal and Contributory Factors

- Aircraft Departure Errors: Pilot takes off without enough runway for safe departure given tailwind and intersection departure. "The accident airplane was observed taking off on the last one-third of the runway."
- Weather: Tailwind affected length of runway required for takeoff. "The VDF 1522 surface weather observation was: wind 220 degrees at 6 knots"
- Unexpected Aircraft Maneuver: Aircraft makes unexpected turn, colliding with an ILS antenna. "…the airplane drifted to the left off the side of the runway. The right wing tip of the airplane collided with a pole; and the airplane cart wheeled to the right, collided with the ground right side up, and immediately caught on fire. "

Observed/Possible Contributory Factors

- Possible Cognitive/Physiological Factors: Undergoing cancer treatment. "The pilot was diagnosed with prostate cancer since his last medical certificate. He was receiving hormone injections every 3 months with his last injection occurring about 4 weeks before the accident. In addition, the pilot had completed 21 out of 25 external radiation treatments for the disease at the time of the accident. Common side effects from such treatment can include irritation, pain, and other symptoms."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2)Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: 1) Performing unsafe altitude resolutions and 2) Issuing unsafe condition advisories
- Manage Departing and Arriving Traffic: 1) Managing ground departure traffic and 2) Issuing takeoff information and instructions

NTSB Report NYC04FA185A

Causal and Contributory Factors

- Visual Scan: Incomplete scan of aircraft location. Neither pilot could physically observe the other aircraft for a majority of the event. "Both airplanes collided while in straight and level flight. A visibility study was conducted using the GPS position data recovered. According to the study the airplane visibility charts the pilot of the Cessna had an approximate 21 second opportunity to acquire the Piper had he been scanning down and to his right, while cruising at 2,600 feet." "A number of assumptions were required before the data could be utilized to determine if and when the pilot of one airplane could see the other, and where in the pilot's windscreen the other airplane would have appeared."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, and 2) Performing visual and radar separation of aircraft and vehicle, and 3) Performing nonradar procedures for aircraft
- Manage Departing and Arriving Traffic: 1) Issuing takeoff information and instructions and 2) Managing airborne departures
- Resolve Conflicts: Performing aircraft conflict resolutions

NTSB Report NYC06FA078

Causal and Contributory Factors

- Knowledge/Experience: "The pilot did not hold an instrument rating."

- Reduced Visibility: IMC Conditions. Fog, clouds, night. "The accident occurred during the hours of night…"
- Violation: Pilot rated for VFR flight only flew in instrument meteorological conditions. "Under no circumstances should a VFR night-flight be made during poor or marginal weather conditions unless both the pilot and the aircraft are certificated and equipped for flight under instrument flight rules (IFR)."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: Issuing unsafe condition advisories
- Manage Departing and Arriving Traffic: Managing arrivals
- Assess the Impact of Weather: Processing weather information
- Resolve Conflicts: 1) Performing unsafe altitude resolutions and 2) Performing airspace or movement area violation resolutions

NTSB REPORT NYC07FA009

Causal and Contributory Factors

- Flight Planning – Pilot did not understand the details of the flight plan and its procedures. "Upon filing the flight plan, the briefer asked the pilot, 'Now, you are aware that you are departing an ADIZ [Air Defense Identification Zone], right?' The pilot responded in the affirmative."
- Knowledge of Procedures: Pilot did not understand ADIZ procedures, nor did he understand the boundaries of the ADIZ, special use airspace. "According to the NOTAM, 'Before departing from an airport within the DC ADIZ or before entering the DC ADIZ, pilots must file and activate an IFR flight plan…' and 'Before operating in the DC ADIZ, pilots must get a discrete transponder code from ATC and must continuously squawk that code until leaving the DC ADIZ.' Additionally, 'Pilots must establish and maintain two-way radio communications with the appropriate ATC facility before entering and while operating in the DC ADIZ.' "
- Unstabilized Approach: Pilot made a rushed approach and crashed. "…the airplane was traveling 'very fast,' and closer to the airport than airplanes in the traffic pattern normally were. He heard the engine running 'very loud.' The airplane then turned 'very steeply' to the left, 'almost vertical,' and the witness could see the top's [sic] of both wings. As the airplane turned steeply to the left, it began descending. The airplane continued in the steep descending turn towards the runway but 'overshot' the extended centerline, and disappeared from the witness's view behind trees." "The airplane 'had quite a bit of speed,' and entered a steep, rapidly-descending left turn. As the airplane continued the turn onto the final approach, it was right of the runway centerline and 'too low.' "

Observed/Possible Contributory Factors

- Repeat Offender Of Procedure: "A review of the pilot's FAA airman file revealed that on April 30, 2004, the pilot was sent a 'Notice of Proposed Certificate Action.' In the notice, the FAA stated that the pilot acted as pilot-in-command of a flight on November 20, 2003, which operated within the Washington, D.C. ADIZ without following the operating requirements and procedures specified at the time. The FAA then proposed to suspend the pilot's certificate for a period of 30 days."

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2)Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Performing nonradar procedures for aircraft, and 4) Responding to special operations
- Manage Departing and Arriving Traffic: 1) Managing ground departure traffic, 2) Issuing takeoff information and instructions, and 3) Managing airborne departures
- Resolve Conflicts: Performing airspace or movement area violation resolutions

NTSB REPORT SEA08FA116A

Causal and Contributory Factors

- Visual Scan: Both pilots made an incomplete scan of aircraft location "The pilot reported that he was not aware of his position relative to the other airplane prior to, and during the collision sequence."
- Communication: Location and intentions of aircraft unknown by one pilot because other pilot failed to announce. "The flight path continued northbound and descended toward the runway. The radar data disclosed that the 172's flight path descended toward the runway from the south consistent with a straight-in approach. The data further indicated that when the 172N was turning onto final approach at 5,600 feet msl, the 172 was at 5,300 msl. "
- Aircraft Approach Error: The straight-in approach was not normal procedure. "A review of the data disclosed that a primary track (transponder code 1200), consistent with that anticipated for N4008F, descended towards the airport from the south consistent with a straight-in approach for runway 34." "The Airport/Facility Directory (AFD) contained the following entry in the 'Airport Remarks' section for the McCall Airport: 'RWY [runway] 16-34 straight in VFR landings prohibited...'" "At non tower airports, avoid entering the traffic pattern on the base leg or from a straight-in approach to the landing runway.'"

ATCT Controller Prevention Tasks

- Manage Communications: 1) Establishing and terminating radio communications and 2) Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, and 3) Performing nonradar procedures for aircraft
- Resolve Conflicts: Performing aircraft conflict resolutions
- Manage Departing and Arriving Traffic: Managing arrivals

NTSB REPORT WPR10FA068A

Causal and Contributory Factors

- Weather: A gusting crosswind "knocked" the glider "around" causing an early return to land.
- Unexpected/Unknown weather: Pilot did not expect such strong gusting winds. "The FAA reported that neither pilot had requested weather reporting services from Flight Service Station prior to the accident."
- Non-Standard Aircraft Approach: Glider took non-standard traffic pattern to return to airport quickly using right traffic when left traffic is standard, likely due to unfavorable weather. "
- Visual Scan: Neither aircraft saw the other on base to final. Neither aircraft maneuvered to avoid one another. "Both aircraft continued on downwind, and turned onto their respective base legs about the same time. As the aircraft turned to final, they collided. One witness reported that neither aircraft performed any abrupt or evasive maneuvers prior to the collision."
- Communication: NORDO- There was no radio for the glider to announce intentions to return in right traffic. The Piper could not know those intentions. "

ATCT Controller Prevention Tasks

- Manage Communications: Issuing clearances, instructions, or other messages
- Manage Air Traffic: 1) Establishing and maintaining positive aircraft or vehicle identification and position, 2) Performing visual and radar separation of aircraft and vehicles, 3) Performing nonradar procedures for aircraft, 4) Monitoring uncontrolled objects/aircraft, and 5) Responding to airborne or ground nonconformance
- Resolve Conflicts: Performing aircraft conflict resolutions
- Manage Departing and Arriving Traffic: Managing arrivals