

2008 SYSTEM SAFETY AVIATION GUIDE



DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

U. S. FOREST SERVICE

INTRODUCTION TO SYSTEM SAFETY

April 2008

Objective: The objective of a Safety Management System (SMS) is to provide a structured management system to control risk in operations. A formal system of hazard identification and safety risk management is essential in controlling risk to acceptable levels. Safety management is centered on a systematic approach to hazard identification and risk management, in the interests of minimizing the loss of human life, property damage, and financial, environmental and societal losses.

Significant attention to safety in the aviation industry has evolved over many years of applying good practices. Continuous improvement in aviation safety, with balance achieved between safety and efficiency, demands that all participants in the system challenge the processes, the culture, and themselves, to identify weaknesses and to seek corrective solutions.

Description: System Safety falls under the umbrella of Safety Management Systems (SMS). The definition of SMS is a Systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. The result is the ability to systemically identify hazards and control risks as well as provide assurance that risk controls are effective. Although we currently do a good job of identifying hazards and controlling risks, we are not realizing the full benefit that a system wide approach provides.

The foundation of SMS consists of four “pillars,” they are Safety Policy, Safety Risk Management, Safety Assurance and Safety Promotion. When fully implemented SMS provides and promotes a Positive Safety Culture. A Positive Safety Culture is an Informed Culture, Flexible Culture, Learning Culture, Just Culture, and a Reporting Culture that captures the operational knowledge and experience of the employees and involves them in the safety achievement process. The desired end result of this cultural shift is to achieve the status of a Highly Reliable Organization (HRO). **

In an **Informed Culture** people are knowledgeable about the human, technical, organizational and environmental factors that determine the safety of the system as a whole. In a **Flexible Culture** people can adapt organizational processes when facing high temporary operations or certain higher levels of risk, shifting from the conventional pyramid organization model to a flatter model. In a **Learning Culture** people have the willingness and the competence to draw conclusions from safety information systems and the will to implement major reforms. A **Just Culture** encourages people (even rewards) to provide essential safety-related information. However there is a clear line that differentiates between acceptable and unacceptable behavior. In a **Reporting Culture** people are prepared to report their errors and experiences. To successfully implement a Positive Safety Culture we need participation from top leadership, down to all of the people accomplishing the mission or task.

Following your review of the stated **Objective and Description** of System Safety, you probably have questions on how to best utilize the Guide, as well as how this fits into “the big picture”.

First the big picture; the agencies started looking into System Safety in 2005. Their findings were positive and in 2006 the BLM entered into an Interagency partnership with the USFS to start work on Aviation Safety Assessments. The first assessments were completed by Interagency Subject Matter Experts (SME) in March of 2007 and were made available on line in May of 2007. These are the second revision, completed in March of 2008, are posted online and have been distributed in hard copy in this **Aviation System Safety Guide**. Our goal is to work towards an Interagency Safety Management System that incorporates all four of the SMS pillars mentioned earlier. Adoption of SMS also brings the agencies into alignment with the minimum aviation safety standards agreed to internationally within guidelines of the International Civil Aviation Organization. (ICAO 9859).

Where are we at with the processes that will achieve the SMS “four pillar” goal?

Pillar number one is **Safety Policy**. We have existing policy in place that supports the foundation of SMS in our aviation safety programs.

Pillar number two is **Safety Risk Management**. This currently is our strongest area, as we have completed Assessments on Helicopter Operations, Rappel, External Loads, Aerial Supervision, SEATs, Heavy Airtankers, and the Infra-Red program.

Pillar number three is **Safety Assurance**. Accident Investigation, Preparedness Reviews, Fire Aviation Safety Teams (FAST), Aviation Safety Assistance Teams (ASAT), SAFECOMs, and numerous other tools monitor and report the health of our prevention efforts. Currently we are working towards implementation of an Aviation Lessons Learned/BLOG web site, trending Interagency SAFECOMs multiple times during fire season, and work towards a “Reporting Culture”.

The fourth Pillar is **Safety Promotion**. We have the ability to implement very positive change in this area by creating a positive “Learning Culture”. Communication is the key to success in this pillar. Training systems are being updated to reflect the principles and procedures being implemented in SMS. Other tools include Safety Alerts, Technical Bulletins, safety memoranda, Aviation Safety Committees, tailgate sessions and video clips such as the Six Minutes for Safety series.

** Weick and Sutcliff, Managing the Unexpected

HOW DO I USE THIS GUIDE?

Risk Management Pillar: The following Aviation Safety Assessments represent one important step in the four pillar, system safety approach. They include Helicopter Operations, Helicopter Rappel, Helicopter External Loads, Single Engine Airtankers (SEAT), Aerial Supervision (leadplane, ASM, air attack), Infra-Red, and Heavy Airtankers. These aviation program risk assessments were first begun in 2007 by interagency teams that incorporated Subject Matter Experts from the respective operations and pilots from each of the flight operations(combined in the term SME), and then revised using updated risk matrices by the SME teams in 2008.

TAB TWO contains **Common System Hazards**. Listed are five systems that house the most commonly reported hazards from all of the SME Teams. Within the Systems are hazards that still require your local action plans in order to reduce the risks in these systems to acceptable levels.

This TAB also houses two supporting spreadsheets entitled **Rotor-Wing Common Hazards** and **Fixed-Wing Common Hazards**. These spreadsheets summarize the most common findings of the SME Teams that are reoccurring trends of high risk across several missions. These spreadsheets were the source of the Common System Hazards listed earlier in the TAB TWO.

TAB THREE through **TAB Nine** contain the individual Hazard Logs developed by each SME Team. These TABS depict mission systems, hazards, risk assessments and mitigations associated with each hazard. These mitigations can be applied to Project Aviation Safety Plans as well as all Aerial Firefighting activities.

TAB Ten contains the four stage risk assessment matrix used by the SME teams. The matrix is accompanied by the definitions of each of the levels of Severity and Probability that result a final risk level stated as Low, Medium, High, or Extreme.

TAB Eleven is a flow chart that can be used as a checklist of items to jog your memory when preparing PASP, monitoring flight operations, or for high risk activity and mishap prevention.

Local action plans should incorporate some or all of the following steps as best practices that will effectively accomplish hazard mitigation. These assessments can and should be used for briefing tools, tailgate safety sessions, Project Aviation Safety Plans (PASP), and especially during periods of increased fire activity. Area Command, Aviation Safety Assistance Teams (ASAT), Incident Management Teams (IMT), Contractor/Vender employees, as well as all aviation users can benefit from reviewing and utilizing this valuable information. We encourage Interagency personnel to utilize our contract pilots to participate in morning briefings and After Action Reviews (AAR) utilizing the applicable assessments.

Interagency Aviation System Safety Assessment

Common Fixed Wing Hazards - **Before Mitigation**

Hazard	Lg. Tanker	Infra Red	SEAT	Aerial Sup.	Risk Level
Aircraft					HIGH
Standardization of a/c/equip	Yes		Yes		
A/C emergency procedures			Yes	Yes	
Operations					HIGH
Acceptance of risk as normal	Yes		Yes	Yes	
Span of Control/collateral. Duties			Yes	Yes	
Congested airspace/urban	Yes		Yes	Yes	
FTA compliance			Yes	Yes	
Inappropriate use of aircraft	Yes		Yes	Yes	
Maintenance Doc./tracking			Yes	Yes	
Lack of adequate base radios			Yes		
Jurisdiction/Boundary awareness			Yes	Yes	
Inadequate pre-post flight			Yes	Yes	
Environment					HIGH
Poor visibility		Yes	Yes	Yes	
Thunderstorms		Yes	Yes	Yes	
Collision W/terrain, wires, towers (CFIT)	Yes	Yes	Yes	Yes	
Collision W/other aircraft			Yes	Yes	
Mountainous terrain		Yes	Yes		
Density altitude H,H,H	Yes		Yes	Yes	
Policy					HIGH
Radio compatibility-St/local			Yes	Yes	
Frequency management			Yes	Yes	
Mechanic qualifications			Yes	Yes	
Ground based radio systems			Yes	Yes	
Differing standards/policies			Yes	Yes	
High visibility markings			Yes		
Lack of inspectors/Standardized			Yes		
Personnel - Human Factor					HIGH
Fatigue	Yes	Yes	Yes	Yes	
Task Saturation	Yes		Yes	Yes	
Conflicting personalities, dissention		Yes		Yes	
Knowledge of equip.-pilot			Yes	Yes	
Lack of CRM crew/contractor			Yes	Yes	
Not keeping up w/technology			Yes		
Lack of FF training-pilot	Yes		Yes	Yes	
Sense of urgency/pressure		Yes	Yes	Yes	
Risk vs. reward			Yes	Yes	
Lack of Situational Awareness and acceptance	Yes		Yes	Yes	

Interagency Aviation System Safety Assessment

Common Helicopter Hazards - **Before Mitigation**

Hazard	Helo Ops	External load	Rappel	RADS	Risk Level
Aircraft					HIGH
Poor visibility due to a/c design	Yes	Yes	Yes		
Long Line Operations, single pilot		Yes	Yes		
Operations					HIGH
Acceptance of risk as normal	Yes		Yes	Yes	
Frequency management, communications	Yes	Yes	Yes		
Inappropriate use of aircraft	Yes	Yes		Yes	
Lack of inspectors, Standardized procedures	Yes		Yes		
Standardization of a/c equipment	Yes		Yes	Yes	
Differing standards/policies	Yes		Yes		
Environment					HIGH
Off site landings, confined area			Yes	Yes	
Density altitude H,H,H; performance, LTE	Yes	Yes	Yes	Yes	
Collision/Rotor strike with trees, wires (CFIT)	Yes	Yes		Yes	
Personnel - Human Factor- Government					HIGH
Inability to bring crew on early for training	Yes		Yes	Yes	
Fatigue	Yes	Yes	Yes		
Sense of urgency/pressure	Yes			Yes	
A/C emergency procedures	Yes			Yes	
Mission complexity beyond experience	Yes		Yes		
Personnel - Human Factor- Contractor					HIGH
Fatigue	Yes	Yes	Yes		
Lack of FF training-pilot	Yes	Yes	Yes		
Knowledge of equip.-pilot	Yes	Yes	Yes		
Keeping up w/technology	Yes	Yes	Yes		
Maintenance Doc./tracking	Yes		Yes		
Long-Line proficiency/Training		Yes	Yes	Yes	

Common Hazards

Interagency Aviation System Safety Assessment 2008:

The result of the 2008 System safety review is that there are five major systems that continue to exhibit high-risk trends which are not adequately mitigated.

I. Common System Hazards: This information was gathered from the program risk assessments conducted by SME's and pilots involved in each aerial suppression mission.

The following hazards were recognized more often than any other area, as high risk- high exposure operations that require further system mitigation to achieve an acceptable level. Each system, and associated hazard is identified on the column at the left. The right hand column states the effectiveness of existing mitigations. Hazards listed as **NO** in **RED INK** require additional management attention to lower the risk to an acceptable level in order to prevent future accidents in this high risk activity. Recommended mitigation actions are listed under roman numeral II. below.

<u>System</u>	<u>Acceptable Mitigation?</u>
A. Operations -	
1. Acceptance of Risk as Normal	NO
2. Inappropriate Use of Aircraft	Yes
B. Environment –	
1. Collision With Terrain, Trees, Wires (CFIT)	NO
2. Density Altitude, (Hot, High, Heavy)	Yes
C. Policy –	
1. Differing Standards/Procedures Between Agencies & Offices	Yes
2. Lack of Inspectors/ Standards	NO

D. Personnel –

- | | |
|--|-----|
| 1. Fatigue (All Personnel) | NO |
| 2. Lack of Training, Qualified personnel (All Personnel) | NO |
| 3. Knowledge/Proficiency With Equipment (Flight Crew) | Yes |

II. Mitigating Actions for Acceptable Level of Risk

This describes the current system defenses that prevent hazards from becoming accidents. Where the risk is not lowered to an acceptable level, or continues to exhibit a current accident/incident trend, additional mitigations are recommended.

A. Operations

1. Acceptance of Risk as Normal: This has been widely recognized as a cultural issue that is prevalent in the field and in management.

RECOMMEND: To continue agency-wide emphasis on a change in culture toward the level of a Highly Reliable Organization. (a) This requires changes in **policy, doctrine and training systems**. Work is underway in these areas but not completed. (b) All contracts should include a requirement for service providers to implement their own safety programs incorporating System Safety elements.

2. Inappropriate Assignment of Aircraft: The field perception is that there are too many untrained personnel involved in the daily assignment of aircraft to our complex mission environment.

MITIGATED: New positions are being used as national aircraft coordinators that will help to reduce this hazard to an acceptable level.

B. Environment

1. Collision with Terrain, Trees, Wires (CFIT): CFIT is the main category of accident/incident occurrence in all aviation missions. The highest probability of this occurrence is during single pilot, low-level flight operations during the firefighting mission.

RECOMMEND: Where practicable, modify contracts to require a second pilot in the aircraft (especially in helicopter long-line operations). SEAT operations should be provided with **aerial supervision** during all complex operations that impose the possibility of pilot task saturation.

2. Density Altitude, (Hot, High, Heavy): Hot high, and Heavy conditions are recognized as a common hazard to all mountain flying operations. Awareness of this hazard has been elevated through improved training of flight crews, field personnel and dispatchers.

MITIGATED: Continued attention to this operating environment and maintaining the situation awareness at all levels.

C. Policy

1. Differing Standards Between Agencies and Offices: Interagency standards have been recognized as an issue for over 30 years. All agencies have applied extensive training on the subject and continue to develop guides and handbooks to further reduce operating failures.

MITIGATED: Continued awareness at all levels of the organization and leadership flexibility to conduct appropriate work-around solutions.

2. Lack of Inspectors/Standards: The common failure cited is a lack of adequate time allotted during inspections, lack of sufficiently experienced inspectors, or a lack of standardized inspection procedures that result in missing critical safety items. This includes errors in determining pilot experience or performance; vendor shopping among agencies for aircraft/pilot carding; missed standard equipment items; rushed inspections; lack of adequate staffing to maintain the nation scope of operations.

RECOMMEND: Additional qualified inspectors are needed in the field to adequately reduce this type of hazard to an acceptable level.

D. Personnel

1. Fatigue: All assessment teams listed short term and cumulative fatigue as a major concern. This becomes especially concerning during peak periods of activity that are further complicated by changes in work/rest cycles, poor eating habits, high heat - high stress situations, work away from the home unit, and repetitive state of dehydration.

RECOMMEND: There is insufficient data available in the firefighting environment to be able to make a scientifically sound recommendation at this time. Evidence suggests that existing work rest guidelines have not been effective in preventing error or eliminating accidents. Additional awareness and prevention is needed in order to curb the causal factors of human error due to fatigue.

2. Lack of Training/Qualified Personnel: This is predominant in three areas (a) seasonal federal employees are not brought on early enough to receive proficiency training prior to high-risk mission assignments, resulting in poor and unsafe performance in the field. (b) Contract personnel, especially pilots, are not trained by the service provider in our mission environment. Special flight activities including long-line operations, mountain flying, and firefighting need thorough pre-

contract training to be conducted for new employees prior to their assignment in the field. (c) Due to high turnover and retirements, there is a lack of qualified aviation personnel, especially ATGS and AOBD positions.

RECOMMEND: (a) The agencies fund additional time for specialized training of seasonal personnel that are assigned in these high risk missions. (b) The agencies fund the development and conduct of specialized training for contract personnel in these high risk missions. (c) Prioritize the training and replacement of ATGS and AOBD personnel in order to maintain adequate levels of safety oversight in field operations.

3. Knowledge/Proficiency with Equipment: It is common in the industry to rotate pilots among multiple aircraft. With the rapid change in complexity of new technology, and additional contract requirements for GPS, AFF, FM radios, etc. the flight crews have not been adequately trained to become proficient in the use of the wide variety of equipment installed in contracted aircraft.

MITIGATED: Agency inspectors are advised to take extra time to assure that flight crews are familiar and proficient in all installed avionics equipment. Upon reaching the assigned field site, managers should allow time for pilot proficiency and familiarization of all installed equipment prior to mission flying.

System - Aircraft		08 Aerial Supervision Assessment						
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Avionics	Avionics failures: overheating, faulty wiring, etc.	Occasional	Marginal	Medium	Integrate into preflight checklist. Add to phase/hourly inspections. Thorough post season inspection. Identify radio location to ensure adequate ventilation. Use extra radio sparingly. Proactive maintenance schedule. When one wire fails replace entire wiring harness.	Improbable	Marginal	Medium
	Inaccessible avionics components	Occasional	Negligible	Low	Mount components in accessible areas. Change contract to reflect this? Standardize within AC Models?	Improbable	Negligible	Low
	Flight crew unfamiliar with components.	Occasional	Marginal	Medium	Training, briefings, carding, pre-flight inspection.	Remote	Marginal	Medium
Configuration	Poor visibility	Occasional	Negligible	Low	Avoid low wing for ATGS operations. High wing provides substantially more visibility. Ensure aircraft is appropriate for the mission.	Improbable	Negligible	Low
Performance Standards	Poor engine performance (single/twin, turbin/recip).	Occasional	Catastrophic	High	Avoid high density altitudes. Download cargo/fuel load. Relocate to favorable location. Alter the mission. Upgrade the aircraft. Ensure aircraft is appropriate for the mission. Perform pre-flight planning.	Remote	Catastrophic	Serious
Contracting - CWN VS Exclusive Use	Sub-standard avionics components.	Occasional	Negligible	Low	Add TCAS/AFF to CWN contracts.	Improbable	Negligible	Low
	Low ATGS CWN pilot skill/fire experience leading to sub-standard performance during flight operations.	Remote	Critical	Medium	Conduct thorough briefings. Ride along with veteran fire pilot. Document performance via contract evaluation process. CWN/ARA Contractors need to receive better training, possibly in the form of computer-based training. Require Air Attack pilots to take a check ride every three years.	Improbable	Critical	Medium
Fuel	Bad fuel	Occasional	Critical	Serious	Prior to re-fueling from an unknown source, ensure fuel is tested for type and quality. Monitor quantity pumped.	Remote	Critical	Medium

System - Flight Operations								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Fire Operations	Poor visibility (smoke)	Frequent	Catastrophic	High	Determine effectiveness of the operation (risk vs. benefit) and discontinue if warranted. Limit number of aircraft in operating area. Increase vertical/horizontal separation of aircraft.	Occasional	Catastrophic	High
	Wake turbulence and speed differential (SEATs)	Frequent	Critical	High	Use show me or chase profile. Use lead profile only when necessary. Performance maneuvers (e.g. Steep turns and pushovers) should be communicated to other aircraft. SEAT performance (speed) needs to be pre-determined in order to set the correct drop speed.	Occasional	Critical	Serious
	Weather (turbulence/wind/thunder storms)	Frequent	Critical	High	Adjust tactics or shut down air ops. Increase vertical/horizontal separation of aircraft. Utilize human aided technology (weather radar, etc.). Encourage	Occasional	Critical	Serious
	Fuel management	Occasional	Critical	Serious	Monitor fuel quantities. Follow fuel transfer procedures. Pre-flight the aircraft. Plan the flight; know refueling locations. Query other aircraft.	Remote	Critical	Medium
	Density altitude	Frequent	Catastrophic	High	Relocate aircraft. Consult performance charts. Download fuel.	Remote	Catastrophic	Serious
	Exposure to terrain in low level environment (Lead/ASM).	Frequent	Catastrophic	High	Ensure high and mid-level recon is completed prior to commencing low level flight. ASM - ATS assists ATP with aerial/ground hazard identification and instrument monitoring (airspeed, altitude, hard deck, etc.). Perform only pertinent radio communication.	Remote	Catastrophic	Serious
	Operating in close proximity to other aircraft (collision potential).	Frequent	Catastrophic	High	Conduct only pertinent communication with the ground (line clearance, etc). Maintain "eyes out" for hazards (terrain, vegetation, birds, other aircraft, etc). ASM - ATS assists ATP with tracking other aircraft (spacing, location, closure, etc).	Remote	Catastrophic	Serious
	Obstructions (towers, cables, wires, etc)	Probable	Catastrophic	High	High level recon, hazard/sectional map, consult ground personnel/other AC.	Remote	Catastrophic	Serious
	Reliance on technology: TCAS, WSI, GPS, Laptops. Flight crew members spending too much time looking at things inside the cockpit instead of out.	Frequent	Critical	High	Remember the eyes are the primary tool for spotting traffic. Don't rely too much on TCAS. Don't ignore TCAS traffic warnings with a tanker in tow (Lead). Prioritize tasks (i.e.: mapping vs. looking for traffic/hazards while in low level ops). Utilize good CRM practices.	Occasional	Critical	Serious
Aircraft emergency	Remote	Catastrophic	Serious	Crew should be trained and remain familiar with a/c systems and emergency procedure checklists.	Remote	Catastrophic	Serious	

System - Flight Operations (Cont.)

Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Fire Operations	Lack of situational awareness	Occasional	Catastrophic	High	Proper rest, thorough briefing (incoming and change out between aerial supervisors), use TCAS/TCAD, use appropriate tactics, maintain commo with other AC/ground/disp. Utilize CRM.	Remote	Catastrophic	Serious
	Sense of urgency	Frequent	Critical	High	Monitor radio traffic, remain calm, follow incident strategy/tactics.	Remote	Critical	Medium
	Exceeded span of control	Frequent	Catastrophic	High	Ensure roles and responsibilities are assigned and understood within aerial supervision crew. Assign aircraft to common functions and tasks with a single point of contact. Hold aircraft at base to limit the number of assigned aircraft over the incident.	Remote	Catastrophic	Serious
	Urban interface/congested areas	Remote	Catastrophic	Serious	Establish flight paths; avoid creating hazards to persons or property on the ground. Lead/ASM must be on order and ATGS must be on scene prior to airtanker operations. Aerial supervision must have positive communication with the IC or designated ground contact.	Remote	Catastrophic	Serious
	Lack of air to ground coordination	Frequent	Critical	High	Use proper frequencies, maintain positive communication, ensure strategy and tactics are clear and understood, use only common terminology, ensure line clearance, solicit feedback. Move helicopters to Division or tactical frequencies as needed. Request more frequencies as needed.	Occasional	Critical	Serious
	Improper drop heights	Occasional	Critical	Serious	Strictly adhere to minimum drop heights (60 feet for SEATs and 150 feet for heavy tankers). Solicit and utilize feedback from ground. Improve and conduct training for tanker/SEAT pilots.	Remote	Critical	Medium
	Target fixation	Probable	Critical	High	ASM should assist single pilot operations in maintaining situational awareness.	Remote	Critical	Medium
	Missing radio calls/Poor communications (air to air)	Frequent	Critical	High	Make sure Air to Air frequency is clear when lead and tankers are on final drop run. Ensure frequency assignments are understood by air and ground personnel. Ensure volume knobs are adjusted properly. Prioritize radios during fire ops (i.e.: Air to Air vs.	Probable	Critical	High
	Missing radio calls/Poor communications (air to ground)	Frequent	Critical	High	Make sure ground contact is available on the radio during tactical operations. A ground contact with a non-scanning radio dedicated to the air to ground frequency is helpful. Provide training to ground personnel.	Probable	Critical	High
	Poor/unclear tactics	Frequent	Critical	High	Maintain positive communications with ground resources. Ensure strategy and tactics are clear/understood. Use only common terminology, solicit/utilize feedback. Provide communication training for ground crews.	Occasional	Critical	Serious
Low aircrew experience levels	Occasional	Critical	Serious	Training/mentoring, qualifications/currency, CRM, brief/debrief, honest feedback.	Remote	Critical	Medium	

System - Flight Operations (Cont.)

Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Fire Operations	PPE not utilized	Occasional	Critical	Serious	Ensure flight crews understand/implement PPE policies and are held accountable.	Remote	Critical	Medium
	Checklists not utilized	Occasional	Critical	Serious	Ensure flight crews are using checklists.	Remote	Critical	Medium
	Shoulder restraints not utilized when available.	Occasional	Critical	Serious	Ensure flight crews are using restraints.	Remote	Critical	Medium
	Inefficient operational use of tactical aircraft	Probable	Critical	High	SOPs for all tactical aircraft types. Right tool for job. Training, feedback, brief/debrief.	Remote	Critical	Medium
Airspace	FTA: Aircraft not complying with procedures.	Frequent	Catastrophic	High	Aerial supervision is trained and enforces FTA procedures. Utilize virtual fences, IP's, quadrants, etc.	Occasional	Catastrophic	High
	Special use airspace: Aircraft not complying with procedures.	Probable	Critical	High	Deconflict SUA. See and avoid. Know SUA areas. Establish comms with controlling agency. Thorough briefings. Training for flight crews.	Remote	Critical	Medium
	TFR: Aircraft not complying with procedures.	Probable	Catastrophic	High	Dispatch in contact with media. Utilize airspace coordinator. Communicate intrusions. Monitor/assign TFR Frequency.	Remote	Catastrophic	Serious
	Incident location: Fires in proximity to congested airspace (airport approaches/high GA traffic areas). Potential for mid-air collision.	Probable	Catastrophic	High	Validate TFR as incident expands, Deconflict SUA, Establish comms with controlling agency, notify other aircraft. Provide TFR transition corridors for non-incident aircraft on large incidents. Increase awareness of GA operators and other agency flight crews not assigned to incident.	Remote	Catastrophic	Serious
Planning	Flight routes need to be planned to account for average terrain height. Sufficient time in emergency to glide to safe landing area.	occasional	critical	Serious	Prepare pre-season route planning to identify best enroute cruise altitude, single engine glide distance, and locations of safe landing areas or back country airports.	Occasional	marginal	Medium

System - Dispatch								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Communications	Radio frequency congestion	Frequent	Critical	High	Make alternative frequencies readily available. Publish secondary frequencies.	Remote	Critical	Medium
	Flight following on district frequencies	Probable	Critical	High	Assign local flight following frequencies. Utilize AFF. Utilize National Flight Following.	Remote	Critical	Medium
	Lack of available frequencies	Frequent	Critical	High	Obtain and publish more FM and AM frequencies for fire operations.	Remote	Critical	Medium
	Frequency management - lack of timely response to additional frequency orders.	Probable	Marginal	Serious	ROSS orders through NICC are too slow. Make frequencies available at the GACC level.	Remote	Marginal	Medium
	State/County/Rural resources on different bandwidth.	Probable	Critical	High	Design a system which establishes compatibility between Fed and State/County/Rural radios. Provide training to agency personnel addressing the differences between radio systems.	Remote	Critical	Medium
	Non dedicated/published frequencies within geographic areas.	Frequent	Critical	High	Obtain and publish more FM and AM frequencies for fire operations at the GACC/local level.	Remote	Critical	Medium
	Centers assigning Leadplanes as ATGS	Occasional	Critical	Serious	Ensure dispatchers are aware that most lead pilots are not ATGS qualified.	Remote	Critical	Medium
	Duplicate frequency assignments within same geographic area.	Probable	Marginal	Serious	Better oversight of frequency allocation/use at local/GACC level during periods of high/large fire activity.	Remote	Marginal	Medium
Equipment	Outdated radio equipment/poor reliability.	Probable	Critical	High	Allocate funding for equipment and personnel to repair/replace radio/commo systems.	Remote	Critical	Medium
	Lack of technical support for radio system repair.	Frequent	Critical	High	Establish dedicated positions for radio techs. Scrap outsourcing and centralizing. It's too slow.	Remote	Critical	Medium
Training	Aircraft dispatcher	Frequent	Critical	High	Funding for training and proficiency. Establish an aircraft dispatcher position with IADP as a requirement.	Remote	Critical	Medium

System - Personnel								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Human Factors	Aircrew fatigue/burnout	Probable	Critical	High	Maintain a sensible diet and hydration. Limit mission time and request relief to allow for adequate rest periods. Monitor fatigue levels of flight crews. Adjust flight schedules to incorporate adequate rest that consider environmental factors that contribute to fatigue.	Occasional	Critical	Serious
	Lack of CRM	Probable	Critical	High	Training, brief/debrief, maintain positive attitude.	Remote	Critical	Medium
	Acceptance of risk as normal.	Probable	Catastrophic	High	Validate mission, solicit feedback from others, reevaluate risk vs benefit, or remove the high risk taking individual from the mission.	Remote	Catastrophic	Serious
	Task saturation	Frequent	Critical	High	Delegate duties, Employ CRM using span-of-control guidelines. Adjust tactics as needed.	Occasional	Critical	Serious
	Hazardous attitude: Anti authority, macho, invulnerability, impulsiveness, and resignation.	Frequent	Critical	High	Remove the individual from the mission. Properly supervise employees. Adhere to work-rest guidelines, flight and duty limitations policy, etc. Validate and stick to incident strategy and tactics.	Occasional	Critical	Serious
	Conflicting personalities	Frequent	Critical	High	Brief/debrief, CRM, honest feedback, maintain positive attitude.	Occasional	Critical	Serious
Government	Lapsed qualifications (currency)	Occasional	Critical	Serious	Track mission/refresher experience annually as per the IASG.	Remote	Critical	Medium
	Lack of AD training/currency	Probable	Critical	High	Track mission/refresher experience annually as per the IASG. Utilize GACC ATGS Reps.	Occasional	Critical	Serious
	Proficiency/currency: Non compliance with established standards.	Probable	Critical	High	Plan/budget for annual, bi-weekly proficiency simulations; include actual flight time.	Remote	Critical	Medium
	Lack of tracking work/rest for relief pilots	Occasional	Critical	Serious	Establish tracking system through CO or COR. Modify contract to indicate relief pilot hours.	Remote	Critical	Medium
	Lack of qualified ATGS in	Frequent	Marginal	Serious	Identify dedicated training platforms. Analyze current ATGS qualifications to develop competency in pilots	Occasional	Marginal	Medium
System - Maintenance								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
General Aircraft Maintenance	Maintenance not tracked well (CWN)	Occasional	Critical	Serious	Vendor needs to share maintenance information as aircraft moves between assignments. ATGS should be proactive during the initial briefing. COR/PI should proactively seek maintenance information when the aircraft reports for it's assignment.	Remote	Critical	Medium
	Unqualified maintenance personnel working on the aircraft.	Occasional	Critical	Serious	Ensure task specific qualified mechanics are performing repairs/maintenance.	Remote	Critical	Medium
	Undue pressure on mechanics to keep the aircraft available for assignment.	Occasional	Critical	Serious	Accept the fact that maintenance problems will occur during high use periods. Allow maintenance crews to perform tasks in a stress free environment. COR/PI should encourage maintenance and show latitude when enforcing contract maintenance/availability .	Remote	Critical	Medium

2008- System Safety Assessment - Single Engine Airtankers (SEAT)

SEAT System - SEAT Aircraft

Sub-System	Hazards	Pre-Mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Capabilities	High Density Altitude effects the aircraft quantity/performance	Frequent	Critical	High	Assign appropriate SEAT aircraft for mission and typical DA (Turbine vs. Radial Engine). Conduct pre-project performance planning. Reinforce HHH Training. Acquire incident altitude information when available.	Remote	Critical	Medium
	Inappropriate Aircraft for Mission	Occasional	Critical	Serious	Ensure SEAT is appropriate for temperatures, altitude terrain and mission. Receive feedback from pilots and Aerial Supervisor.	Remote	Critical	Medium
Maintenance	Mechanical Failure	Occasional	Catastrophic	High	Pilot & SEMG monitor maintenance schedule. Pilot reviews & understands emergency procedures.	Remote	Catastrophic	Serious
	Aircraft Improperly Maintained	Occasional	Catastrophic	High	Follow Contract requirements and Aircraft Maintenance Manual. Aircraft inspectors check that FAA maintenance requirements are met. SEMG ensure pre/post flight inspections completed.	Remote	Critical	Medium
Visibility	Smoke/Inversion - Inclement Weather conditions between Airbase & Incident	Frequent	Catastrophic	High	Maintain VMC. Practice See & Avoid. Establish Communications. Ensure sound mission planning is performed and weather briefing is received. Know and understand Fire Traffic Area (FTA). Keep windscreen clean. Pilot and ground resources must maintain Situational Awareness. Pilot should exercise go/no-go option.	Remote	Critical	Medium
	High Visibility aircraft lighting systems	Occasional	Critical	Serious	Aircraft lighting systems need to be utilized and maintained.	Remote	Critical	Medium
	Congested Airspace, Military Airspace, Uncontrolled Airports, Ramp/Taxi Communications.	Frequent	Catastrophic	High	Comply with Interagency Aerial Supervision guide. Ensure effective airspace coordination is conducted between Dispatch & FBOs & Military Units. Understand, review, and discuss the Fire Traffic Area (FTA) in briefings. Review known aerial hazards and acquire complete Dispatch forms prior to dispatching or diverting SEATs. Comply with sterile cockpit procedures & policy . Establish local ramp and taxi protocols in cooperation with local airport operations.	Remote	Catastrophic	Serious
Inspection	Lack of Standardization	Occasional	Marginal	Medium	Ensure implementation of standardized SEAT aircraft and pilot inspection process. Train inspectors on new standards.	Remote	Marginal	Medium
Equipment	Ineffective and out dated equipment	Occasional	Critical	Serious	Equipment required in the contract should be monitored and evaluated. Determine if it is viable to retain as a requirement in the contract. If it does not work - replace it. If it is not needed - remove it from the contract.	Remote	Critical	Medium
	Inadequate Pre-Flight/Post-Flight Inspections	Occasional	Critical	Serious	Agency and vendor should ensure adequate time for Inspection. Encourage pilot to utilize time to complete Inspections. Document Pre/Post Flight Inspections daily.	Remote	Marginal	Medium

SEAT System - SEAT Aircraft (Cont.)

Sub-System	Hazards	Pre-Mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Communications	Changing Technology & Lack of Training	Probable	Critical	High	Inspection & carding process ensure Contractors (Pilots) are skilled with equipment provided - GPS, VHF & UHF Radios, AFF, etc.	Remote	Critical	Medium
	Lack of Radio Equipment Compatibility (Narrow Banding & Frequencies). Future considerations: Digital requirements.	Occasional	Critical	Serious	Continue to work with State, City & County Fire Departments to meet future Federal Standards and compatibility issues. Work with national agency/interagency radio program leaders ensure the policies they develop are compatible with aviation requirements.	Remote	Critical	Medium
	Inadequate Frequency Management	Frequent	Catastrophic	High	Conduct effective air base in-briefings. Develop specialized training-simulations. Conduct frequent AARs and/or sand table exercises. Perform periodic reviews of frequency lists and avionics equipment operations. Check radio systems following relief pilot duty. Ensure that positive communications are established.	Remote	Critical	Medium
	Radio Frequency Congestion	Frequent	Critical	High	Make alternative frequencies readily available. Publish secondary frequencies. Utilize AFF when possible to reduce congestion. Maintain effective working relations with frequency coordinators.	Remote	Critical	Medium
	Lack of District flight following frequencies	Probable	Critical	High	Assign discreet local flight following frequencies whenever possible. Utilize standardized AFF procedures. Utilize National Flight Following if necessary.	Remote	Critical	Medium

SEAT System - Maintenance

Sub-System	Hazards	Pre-Mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Documentation	Maintenance not tracked well.	Occasional	Critical	Serious	Vendor needs to share maintenance information as SEAT moves between assignments. SEMG should be proactive during the pre-use inspection. PI should proactively seek and document maintenance information when the aircraft and pilot reports for assignment.	Remote	Critical	Medium
Inspection/Evaluation Process	Not Enough Inspectors	Occasional	Critical	Serious	Train and utilize more Interagency Inspectors with past SEAT program experience and knowledge.	Remote	Critical	Medium
	Experience and/or knowledge level of contractor personnel assigned to perform maintenance duties is unknown.	Occasional	Critical	Serious	Emphasis should be focused on verification of credentials by Government Inspectors. PI should coordinate with COTR.	Remote	Critical	Medium
	Distractions created by Collateral Duties (A&P/driver/mixer etc).	Occasional	Critical	Serious	Avoid overloading support personnel with responsibilities and workload. Utilize additional crew members as necessary.	Remote	Marginal	Medium

SEAT System - SEAT Base Facilities (Permanent & Temporary)

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Communications	Lack of Adequate Radio Equipment, Computers & IT Support	Occasional	Critical	Serious	Continue efforts to upgrade/improve communications and IT equipment, and program support on an annual basis.	Remote	Critical	Medium
Security	Unsecured Air Base Facilities increase risk of sabotage.	Frequent	Critical	High	Comply with Contract requirements. Discuss and exercise after-hours options to provide security. Address security concerns during initial briefings.	Remote	Critical	Medium
SEAT Base Standards	Inadequate Runway Minimums.	Frequent	Critical	High	Verify that length, width and surface conditions, congested area and elevation for minimum operational use are adequate. (Make & Model of aircraft).	Remote	Critical	Medium
	Inadequate Ramp Space Minimums	Frequent	Critical	High	Verify that length, width and surface conditions for type and number of equipment and aircraft are adequate.	Remote	Critical	Medium

SEAT System - SEAT Contracts								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
On-Call vs. Variable Term	Lack of Continuity, Efficiency, Training, Familiarization and CRM with Contractor Personnel and Local Operations.	Frequent	Critical	High	Utilizing more Variable Term contracts will increase continuity between contractor and local unit which produces better CRM and reduces exposure/safety issues for managers and ground personnel.	Remote	Critical	Medium
SEAT System - Personnel (Government)								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Utilization	Span of Control	Frequent	Critical	High	Ensure that base operations plans address contingency to handle events where span-of-control may be exceeded. Home units need to mitigate this issue by pre-training and recruitment of supplemental personnel.	Occasional	Critical	Serious
Management	SEAT Managers & ATB Managers are not fully aware of Aircraft Maintenance Issues.	Frequent	Marginal	Serious	Agency personnel need to rely upon AMD Technical Service Maintenance Inspectors to determine proper maintenance procedures and authorization to return the aircraft to contract availability.	Remote	Marginal	Medium
Training	Lack of knowledge and experience in Aviation Contract Administration and Aviation Program Management for SEAT Manager Trainees.	Occasional	Marginal	Medium	Recommend SEAT Manager at least attend ACE or equivalent aviation contract administration courses. Add new information in the next rewrite of S-273. Also highly recommend a season of wildland fire line experience.	Remote	Marginal	Medium
Human Factors	Fatigue	Probable	Critical	High	Adhere to established work-rest policy/guidelines and promote additional off-time when possible. Request additional staffing and/or detailers during peaks of high fire activity.	Remote	Critical	Medium
	Acceptance of Risk as Normal	Probable	Critical	High	Emphasize importance of "situational awareness" as a means to recognizing risk. Consider utilization of the SEAT Coordinator, SEAT Program Manager positions as a method of mitigating risk. Provide Risk Management Training for the SEMG.	Remote	Critical	Medium
	Changes in standard operating procedures not known	Probable	Marginal	Serious	Clarify & Confirm Program changes. Notify appropriate personnel, in a timely manner. Accept questions and seek out responses.	Remote	Marginal	Medium
Experience	Variable Term vs. On-Call SEAT Manager.	Frequent	Marginal	Serious	Provide program oversight (Local, State or Natl., IQCS) to ensure that SEMG meet currency experience requirements and have completed tri-annual refresher as per ISOG	Remote	Marginal	Medium
	Aerial Supervision - Lack of SEAT specific knowledge and experience	Probable	Critical	High	Provide thorough pre-mission briefing, conduct post-mission AARs and have an experienced ATGS ride-along if available. Include specific SEAT section for ATGS training.	Remote	Critical	Medium
Policy/ Procedure	Policy Deviation	Occasional	Marginal	Medium	Re-enforce and emphasize to SEGMS to communicate with SECOs, Contracting Officers, SAMs, etc. when questions and issues arise.	Remote	Marginal	Medium
	Multiple Agencies - Differing Standards (State vs Fed)	Frequent	Critical	High	Recommend continued development & implementation of Interagency standardized SEAT program management and policy.	Occasional	Critical	Serious
SEAT System-Personnel (Contractor)								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Utilization	Drivers not understanding/following DOT Policy/Regulations	Occasional	Marginal	Medium	Stronger emphasis by agency to contractor regarding their responsibility to comply with policies and regulations (rest, driving and duty).	Remote	Marginal	Medium
Training - Pilot	Potential for Inadequate SEAT Pilot Training	Occasional	Critical	Serious	Continue with further development of contractor SEAT Pilot training program opportunities and/or BLM/FS NAFA & SEAT Pilot Academy.	Remote	Critical	Medium

SEAT System-Personnel (Contractor Cont.)

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Training - Mixers & Loaders	Not all Mixers & Loaders are adequately trained and qualified.	Occasional	Critical	Serious	Ensure that contractors provide adequate training to ground personnel prior to fire assignment. Provide training documentation to agency aviation managers on the mixing and loading of fire chemical retardant products.	Remote	Critical	Medium
Human Factors	Ground support personnel fatigue	Probable	Critical	High	Ensure contractor compliance with rest and duty limitations for ground support personnel so as not to overextend. (Company and agencies are responsible to monitor closely). Utilize additional crew members as necessary.	Remote	Critical	Medium
	Ground Personnel - poor decision making, multi tasking, mission focus, sense of urgency, peer pressure	Probable	Critical	High	Ensure that these items are addressed in the contract pre-work meeting and re-enforced in the daily air base briefings, post mission briefings or whenever the need is identified.	Remote	Critical	Medium
	Pilot fatigue	Probable	Critical	High	Ensure contractor compliance with rest and duty limitations for Pilots so as not to overextend. (Company and agencies responsibility to monitor closely). Allow additional time off if needed or requested. Request relief Pilot if available.	Remote	Critical	Medium
	Pilot - poor decision making: multi tasking, mission focus, sense of urgency, peer pressure	Frequent	Critical	High	Ensure that these items are addressed in the contract pre-work meeting and re-enforced in the daily air base briefings, post mission briefings or whenever the need is identified.	Remote	Critical	Medium
	Acceptance of Risk as Normal	Probable	Catastrophic	High	Emphasize importance of "situational awareness" as a means to recognizing risk. Consider providing Risk Management Training for the Pilot. Re-address complacency and self discipline in daily air base briefings.	Occasional	Critical	Serious
	Poor CRM with crew rotations; Crew rotation may affect aircraft/equipment knowledge	Probable	Critical	High	Make effort to ensure that contractor relief personnel arrive at base prior to relief cycle with sufficient overlap time to receive good in-brief from primary pilot.	Occasional	Critical	Serious
	Single Pilot workload may be considered to be excessive based on demands that he/she be able to operate several cockpit equipment items during mission performance (i.e. Multi-Tasking Overload.).	Frequent	Critical	High	Utilize Aerial Supervision if available to reduce cockpit workload. Utilize newer technology such as AFF to minimize radio traffic. Conduct AARs, sand table exercises and on ground CRM Exercises. Incorporate Operations personnel in simulations and exercises.	Occasional	Critical	Serious
Conflicting and/or Difficult Personalities	Probable	Critical	High	Conduct effective and objective briefings and debriefings. Encourage honest feedback. Maintain positive and professional attitude. Document discussions and briefings.	Occasional	Critical	Serious	
Experience	Older and more-experienced pilots are retiring creating an influx of younger, less-experienced pilots.	Occasional	Critical	Serious	Use opportunities for flight proficiency exercises with ground forces in addition to sand table exercises. Agency needs to evaluate current training standards to ensure they meet changing program needs. Maximize opportunities to pair experienced SEAT pilots with less experienced SEAT Pilots on fire missions (pilot mentoring). Maintain and expand opportunities within the industry SEAT Pilot training programs and the BLM SEAT Pilot Academy.	Remote	Critical	Medium

SEAT System-Technology

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
New Technology	Lack of familiarity with technology, inability to utilize and operate equipment.	Occasional	Critical	Serious	Take a stronger approach with all personnel (Pilots, Dispatchers, Managers, etc.) to ensure that they are trained in the function and operation of newer tech-equipment and systems prior to implementation and utilization.	Remote	Critical	Medium
Standardization	Lack of standardized aircraft, support equipment, and communications equipment.	Occasional	Critical	Serious	Standardize equipment specifications through the procurement process and mandate within the contract solicitation. Work with contractors to emphasize the importance of standardization.	Remote	Critical	Medium

SEAT System - SEAT Operations

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Agency Radio System	Lack of technical support/inadequate support system.	Frequent	Critical	High	Agency radio system needs to be replaced, re-designed and upgraded to accommodate current demand and volume of use for current Fire & Aviation programs, as well as those of the future. (Standardize and buy user friendly equipment.) Maintain close working relations with agency radio program leaders to ensure aviation needs are addressed.	Occasional	Critical	Serious
Missions	Inefficient use of SEATs may result in unnecessary risk exposure to SEAT Pilot and ground personnel. (Risk vs. Reward)	Frequent	Critical	High	SEAT Pilot, Fire Managers, Dispatchers, line personnel, and aerial supervisors need proper education on use of SEATs. Use AAR as mitigation tool to prevent re-occurrence. Conduct pre and post -mission briefings.	Occasional	Marginal	Medium
	Jurisdiction & Border Issues	Occasional	Critical	Serious	Agency and Contractor should provide training and orientation. Local unit to brief and initiate utilization of the local Airspace Boundary Plan.	Remote	Critical	Medium
	Defined standard Lead Plane profiles for SEATs	Probable	Critical	High	Re-enforce local Interagency Lead Plane SOPs for SEAT aircraft tactical operations. Contractors need to also address SEAT/Lead Plane SOPs during annual training.	Remote	Critical	Medium
	Flying low level at operational weights and airspeeds in areas with hazards.	Frequent	Catastrophic	High	Perform high level reconnaissance prior to descending to work in the low-level environment. Utilize aerial supervision when available. Utilize proper aircraft energy management techniques.	Remote	Catastrophic	Serious
	Inexperienced Personnel-Government & Contractors	Frequent	Critical	High	Agency & Contractors need to evaluate required training to determine if personnel are staying current with program needs.	Remote	Critical	Medium
	A Sense of urgency may be placed on Contractor personnel at various points in the mission.	Occasional	Critical	Serious	Address the SAFETY vs. URGENCY issue as a special-emphasis item during in-briefing with contractor and agency employees. Reinforce this throughout the entire operational period.	Remote	Critical	Medium
	Drop Height Minimums	Frequent	Catastrophic	High	Define 60 ft. obstacle clearance as the minimum decent altitude for all fire operations except during takeoff and landing.	Remote	Catastrophic	Serious
	Poor fuel management	Remote	Catastrophic	Serious	Monitor fuel quantities. Follow fuel transfer procedures. Pre-flight the aircraft and plan the flight. Know refueling locations. Query other aircraft - fuel status and availability.	Remote	Catastrophic	Serious
	Wake Turbulence	Occasional	Critical	Serious	Exercise "CAUTION" when sharing local airspace.	Remote	Critical	Medium
Environment	Conflicting Airspace Environment	Occasional	Critical	Serious	Local agency must provide orientation and "situational awareness" overview to SEAT pilots on Special Use Airspace, MTRs, TFRs etc. Assure that Dispatch and aviation program personnel are trained in Dispatch procedures for SUA. Use aerial supervision when available.	Remote	Critical	Medium
	Hazardous and Extreme Weather Conditions.	Frequent	Critical	High	Confirm weather information flow is in place. Confirm that red-flag warnings are distributed. Ensure there are continual updates on changing weather conditions shared between pilots, air base managers, dispatchers, etc. Go-No-Go is PIC decision.	Remote	Critical	Medium
	Hazards and Extreme Terrain	Frequent	Critical	High	Get an adequate mission briefing and use performance planning to prevent CFIT events. Perform high level reconnaissance prior to descending to the low level environment. Use Aerial Supervision when available.	Remote	Critical	Medium
	Congested areas and Urban Interface.	Frequent	Critical	High	Comply with congested area policies and ensure that aerial supervision is in place or has been requested.	Remote	Critical	Medium

SEAT System - SEAT Operations (Cont.)

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Communications	Lack of Available Frequencies	Frequent	Critical	High	Manage available frequencies as best as possible. Request additional frequencies as needed and release frequencies in a timely manner when no longer needed. Train all users in radio discipline.	Occasional	Critical	Serious
	Inadequate clarification of Chain of Command-Who is in charge.	Occasional	Critical	Serious	Validate tactical (A-G & A-A) contacts identified on the Aircraft Dispatch form. Ensure the pilot has a copy.	Remote	Critical	Medium
Performance Planning	Lack of Planning - incorrect calculation of allowable retardant load; weight & balance	Occasional	Critical	Serious	Pilots need to ensure that proper weight and balance and performance planning is completed and shared with base personnel. Utilize appropriate aircraft performance charts for the designated base and area of operations. Base personnel should be aware of trigger points for downloading retardant, water, etc.	Remote	Critical	Medium
	Inadequate runway lengths and/or surface conditions	Occasional	Critical	Serious	Specify length, width and surface conditions, congested areas and elevations for minimum operational use for each make and model of aircraft. This information must be validated by performance planning.	Remote	Critical	Medium
	Lack of information on incident conditions	Occasional	Critical	Serious	Utilize A/C dispatch form, obtain as much information as possible from other aerial and ground resources. Obtain information from Pilot after initial load on additional downloads . Use Aerial Supervision when available. PIC has final authority on go/no go.	Remote	Critical	Medium

System Safety Assessment - Helicopters

Helicopter System -Aircraft

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Capabilities	High DA will overgross the aircraft	Occasional	Catastrophic	High	Use appropriate aircraft for mission. Conduct thorough pre-mission planning, load calculations, etc. Reinforce HHH Training.	Remote	Catastrophic	Serious
	AC not appropriate for mission. ICS Typing	Occasional	Critical	Serious	Ensure appropriate aircraft is ordered & utilized. Conduct thorough pre-mission planning, load calculations, etc.	Remote	Critical	Medium
	Mechanical failure - flight component	Remote	Catastrophic	Serious	Follow IHOG Policy Ch 14 Sched Maint, Pre & Post Flight, etc.	Remote	Catastrophic	Serious
	Equipment not well maintained & operational	Occasional	Critical	Serious	Follow IHOG Policy Ch 9. Ensure personnel receive adequate basic training.	Occasional	Marginal	Medium
Visibility	Lack of Hi Vis AC Markings	Occasional	Catastrophic	High	Identify paint schemes that are NOT highly visible & add that to the contract as NOT approved.	Improbable	Catastrophic	Medium
Inspection	Lack of standardization of Gov't Inspectors	Frequent	Critical	High	Recommend development & implement of Interagency Standardized inspection process. If one Agency does not approve an aircraft or contractor for operation other agencies should follow and accept that decision.	Occasional	Critical	Serious
	Level of Training for HEMGs on inspection process is inadequate	Frequent	Marginal	Serious	Develop training for HEMGs on MEL, maintenance buzz words (Watch-Outs). Act on opportunity for HEMGs to attend inspections.	Occasional	Marginal	Medium
Equipment	Personnel not proficient with equipment	Frequent	Marginal	Serious	Inspectors ensure Contractors (Pilots) are adequately trained & skilled with equipment provided. Ensure contract language requires equipment to be commensurate with current technology.	Occasional	Marginal	Medium
Maintenance	Maintenance in the field	Frequent	Critical	High	Fly aircraft to shop/hanger for maintenance whenever possible. Allow adequate time for mechanics to work in field. Provide light/power/water if possible.	Remote	Critical	Medium
	Lack of thorough documentation	Occasional	Critical	Serious	Develop training for HEMGs on MEL, maintenance buzz words (Watch-Outs). Enhance awareness through training for HEMGs on when to call MI for assistance with Contractor & maintaining equipment.	Remote	Critical	Medium
	Poor Communications between all parties (Contractor, GACC,CO, ACO, COR, PI, MI, HEMG)	Frequent	Critical	High	Enhance and integrate tracking of maintenance records AND Contract Evaluations of the a/c over the duration of the contract period in order to recognize issues-CWN & Ex Use. Hire additional Maintenance Inspectors to keep up with this increased workload.	Occasional	Critical	Serious

Helicopter System - Facilities (permanent and temporary)								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Communications	Lack of adequate base station VHF & FM radios-Not able to adequately communicate to helicopters out working missions/projects with handheld radios.	Occasional	Critical	Serious	Provide all Ex Use crews with mounted FM & AM radios on chase trucks (NOT just handhelds). Utilize Ex Use crews more often on incidents because they have the support equipment. Helibase Commo trailers should be on a National Contract instead of Geographic Area in order to lower cost.	Remote	Critical	Medium
	Lack of adequate computers-not able to access necessary flight planning, ABS, and weather documents prior to missions.	Frequent	Critical	High	Have Cache computers available for Incident/Unit personnel to check out that are Intranet accessible. These computers should be able to access Internet as well for Weather updates, TFR information, filing of flight plans, completing electronic payment forms, etc. Ensure ALL Ex Use bases have Internet as well as Intranet access in order to access critical WX, TFR & Flight Planning information.	Remote	Critical	Medium
Environment	Haz Mat concerns/spills-Lack of adequate spill prevention/mitigation equipment on site and the knowledge to utilize it.	Frequent	Marginal	Serious	Provide permanent as well as temporary helibases with approved Haz Mat storage facilities/equipment. Solicit for National Contracts to provide portable haz mat storage facilities for Incidents	Remote	Marginal	Medium
Inspection/Evaluation	Lack of Accountability/Follow Up on Annual/Triennial Helibase Reviews	Probable	Marginal	Serious	Hold Management accountable to conduct follow up and remedy critical issues found in reviews and adhere to interagency and OSHA standards.	Remote	Negligible	Low

Helicopter System - Personnel (Government)								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Utilization	Span of Control/Collateral Duties. Personnel are often tasked with multiple duties especially during the emergence of an incident. Focused on Task at hand & not able to provide adequate oversight.	Probable	Catastrophic	High	Ensure existing staffing, supervision and management policies & procedures are met. Place aviation resource needs at higher priority level in the resource ordering process. Need to ensure situation is recognized & ensure additional resources/supervision is ordered. Limit collateral duties in key supervisory positions. If unable to fill key positions operations will be shut down or limit use of aircraft until span of control issues are resolved.	Remote	Catastrophic	Serious
Policy	Operational and mission goals during all-hazard assignments may be unstated or unclear and may conflict with interagency standards and policy	Probable	Critical	High	Adequate in-brief and dissemination of Commander's intent. Clarification of scope of authority & policy in place. Adhere to interagency policy, procedures and guidelines (e.g., IHOG). If unable to perform duties utilizing interagency policy, perform a separate Risk Assessment with appropriate approval sign off. Ensure personnel are working within the scope of their employment. Implementation of Aviation Doctrine may further mitigate conflicts between direction and policy.	Occasional	Critical	Serious

Helicopter System - Personnel (Government) - Continued								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Training	Unable to bring seasonals on early enough to provide all the required training prior to sending on incidents	Frequent	Critical	High	Ensure line officers are committed to providing adequate time and funding to develop personnel as necessary.	Occasional	Critical	Serious
	Lack of CRM	Probable	Critical	High	Provide adequate time for training and provide time for Modules to develop CRM prior to field season. Provide training in CRM for Modules annually. Brief/debrief, maintain positive attitude.	Occasional	Critical	Serious
Human Factors	Fatigue/burnout due to incident duration as well as year round All Risk incident support .	Probable	Critical	High	Adhere to work/rest guidelines. Monitor fatigue levels of crews. Rotate personnel and helicopter programs to manage fatigue and burnout. Manage number and duration of assignments. Ensure adequate time off and provide quality R & R while on assignments.	Occasional	Critical	Serious
	Acceptance of high risk missions as normal.	Probable	Catastrophic	High	Review risk assessment & existing policy/procedures, brief/debrief with all personnel and utilize risk management tools to include Go-No-Go Checklists. Educate personnel on the hazards of normalization of risk and complacency. Mission decision made at appropriate level. Must have better communication and collaboration between Operations and Aviation.	Remote	Catastrophic	Serious
	High workload for Maintenance Inspectors may compromise their ability to perform thorough inspections. Standard inspections criteria not followed consistently among agencies or regions.	Probable	Critical	High	Increase amount of personnel available to perform the duties of Maintenance Inspector in proportion with span of control. Ensure inspection standards are developed and maintained by agencies.	Remote	Critical	Medium
	Conflicting personalities resulting in hazardous attitudes.	Occasional	Critical	Serious	If individuals cannot professionally resolve differences, managers and supervisors must intervene immediately. Brief/debrief, employ CRM, provide honest and objective feedback, maintain positive attitude. Maintain professionalism and mission focus at all times.	Remote	Critical	Medium
Helicopter System - Personnel (Contractors)								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Training/Experience	Inadequate/falsification of documentation	Occasional	Catastrophic	High	Adhere to existing contract requirements requiring Contractors to validate pilots' experience and training. Ensure HIPs review pilots' experience records.	Remote	Catastrophic	Serious
	Lack of training in Firefighting strategy, tactics, terminology, basic ICS, frequency mgmt, etc.	Probable	Critical	High	Establish requirements for documentation of online training to meet basic, minimum level of knowledge for all contracts. Consider pilot academy.	Occasional	Critical	Serious
	Pilots unfamiliar and not proficient using and programming contract required radio and navigation equipment	Frequent	Marginal	Serious	Inspectors ensure Contractors (Pilots) are adequately trained & skilled in use and programming of avionics equipment. Ensure contract language requires equipment to be commensurate with current technology.	Occasional	Marginal	Medium
Pilot Experience & Capabilities	Low flight time/experienced pilots	Probable	Critical	High	Develop, implement and support a pilot mentoring program in appropriate contracts. Consider pilot academy.	Occasional	Critical	Serious

Helicopter System - Personnel (Contractors) - Continued								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Human Factors	Fatigue	Probable	Critical	High	Managers work with company personnel to ensure adequate rest. Manage missions to be most effective with proper use of pilots & aircraft. Implement Phase Duty Limitations as appropriate.	Remote	Critical	Medium
	Acceptance of high risk missions as normal.	Probable	Catastrophic	High	Conduct thorough risk assessments & brief/debrief. Pilot and Helicopter Manager train in CRM and work together on mission planning. Mission approval made at appropriate level.	Occasional	Catastrophic	High
	Low CRM with crew rotations (multiple relief pilots)	Frequent	Critical	High	Ensure there incoming crews are thoroughly briefed. Practice CRM, conduct effective AARs, etc. Enforce contract language regarding relief pilot/personnel changes.	Occasional	Critical	Serious
	Conflicting personalities	Occasional	Critical	Serious	Brief/debrief, CRM, honest feedback, maintain positive attitude and professionalism. Immediately take action. Notify Contracting Officer/Inspector Pilot. Don't let problem persist.	Remote	Critical	Medium
	Sense of urgency/pressure/mission driven	Probable	Critical	High	Ensure Managers are not placing undue pressure on pilot. Thorough risk assessment & brief/debrief. Pilot training in CRM with the Helicopter Manager. Pilot participate in Mission development. Mission decision made at appropriate level.	Occasional	Critical	Serious
	Pre-flight/Post-flight inspections not thorough	Occasional	Catastrophic	High	Managers ensure adequate REVENUE time for Inspections. Ensure Managers are briefed/trained on the contract & realize that Contractors do get paid for this time. Encourage Pilot/Mechanic to utilize time to complete Inspections.	Remote	Catastrophic	Serious
Helicopter System - Technology								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Utilization	Lack of standardization of equipment	Frequent	Critical	High	Allow time for the pilot, mechanic, and Helicopter Manager to conduct thorough pre-use familiarization with cockpit layout and avionics equipment.	Remote	Critical	Medium
	Some pilots do not know how to operate radios, GPS, etc. Managers not familiar with equipment.	Probable	Critical	High	Train all personnel to be proficient in the use of avionics equipment on the helicopter as per contract requirements. Provide computer based or hands-on training for various models of GPS units and radios for helicopter managers.	Remote	Critical	Medium
Human Factors	Cockpit overload, pilots flying, programming radios/GPS, dropping water, talking on three different radios, etc.	Frequent	Critical	High	Experience, OJT w/experienced supervision (HIP or Chief Pilot), CRM-work with experienced Helicopter Manager. Ensure appropriate levels of aerial supervision are in place. Encourage pilots to speak up when starting to get overloaded. Discuss safety options with the pilot.	Occasional	Critical	Serious

Helicopter System - Operations								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Missions	Multi tasking-Pilot, Helicopter Manager, Helibase Manager, Helitack Crew personnel, fueler.	Frequent	Critical	High	Ensure existing staffing, supervision and management policies & procedures are met. Order resources early when the need is anticipated. Dispatchers need to recognize aviation staffing is a critical safety priority. Limit collateral duties in key supervisory positions. If unable to fill key positions, operations will be shut down or use of aircraft will be limited until span of control issues are resolved.	Occasional	Critical	Serious
	Complexity beyond capabilities/experience of available resources	Probable	Critical	High	Disengage, reassess & realign objectives until appropriate level of supervision is present. Conduct risk analysis. Ensure situation is recognized & ensure appropriate supervision/resources are ordered. Provide OJT and conduct	Occasional	Critical	Serious
	Poor Aviation Strategy (poor risk vs. reward, heli-mopping, overuse-are there alternative ways of doing this)	Frequent	Catastrophic	High	Utilize safe and effective strategy & tactics. Involve pilot in mission planning. Conduct thorough risk assessment prior to mission. Brief/debrief. Seek appropriate level of approval for high risk missions, i.e. Helicopter Manager, IC, District Manager, Forest Supervisor, etc. Involve Aviation overhead with operational planning of strategies and tactics for the Appropriate Management Response. Avoid risk/exposure	Remote	Catastrophic	Serious
	Jurisdiction/Borders-Mid Air collision avoidance	Frequent	Catastrophic	High	Boundary Airspace Plan developed/utilized. Follow FTA procedures. Utilize airspace coordinator. COMMUNICATE. Establish TFRs as needed. See & Avoid. Utilization of TCAS. Make AFF a requirement on all aircraft contracts.	Remote	Catastrophic	Serious
	Low level flight profile-below 500', Special Use (recons, aerial survey, game count, mapping, etc)	Occasional	Catastrophic	High	Conduct thorough risk assessment training. Thorough risk assessment/mission plan/performance planning is completed and signed at the appropriate level. Minimize exposure time. Utilize Part 27 certificated T3 helicopters. Ensure that the appropriate PPE/ALSE is used and that the flight is limited to essential flightcrew members. Ensure aircraft and pilot are carded for the mission. Conduct high level recon prior to working below 500' AGL.	Remote	Catastrophic	Serious
	PASP/Go-NO-Go Checklist absent or not complete (Policy Deviation)	Occasional	Critical	Serious	Ensure PASP and risk assessment are completed and approved at appropriate level. Ensure Unit Aviation Managers and Forest Aviation Officers are involved in mission planning when necessary. PASP should be used as a briefing tool. Stress that on the "GO/NO-GO" checklist a "NO GO" halts the operation. Ensure that if there are multiple briefings that all information is given at the primary briefing.	Remote	Critical	Medium
Management Decisions	Incident Management Team strategies shift risk from ground operations to aviation operations.	Frequent	Catastrophic	High	Utilize safe and effective strategy & tactics. Involve Pilot in mission planning. Conduct thorough risk assessment prior to mission. Brief/debrief. Acquire appropriate-level approval signatures for high-risk complex missions; i.e. Helicopter Manager, IC, District Manager, Forest Supervisor, etc. Involve Aviation overhead with Operational planning of strategy and tactics for the Appropriate Management Response. Avoid risk/exposure transference.	Remote	Catastrophic	Serious

Helicopter System - Operations - Continued								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Utilization	Inefficient or improper use of Aircraft for the assigned mission (wrong aircraft selected for a mission, flying without tactical/logistical objectives, etc.)	Frequent	Critical	High	Use only an appropriate aircraft for the mission. Conduct thorough pre-mission planning and load calculations. Ensure that tactical/logistical missions have clear, obtainable goals (i.e., Appropriate Aviation Management Response is used). Aircraft assigned should be based on performance and capabilities.	Occasional	Critical	Serious
Environment	Weather: Poor Visibility/Thunder storms/Hot-High DA/Turbulence	Frequent	Catastrophic	High	Obtain most current/accurate weather reports available. Conduct risk assessment & determine need to conduct mission. Wait until conditions improve. Follow policy on visibility, wind speed, updating load calcs, etc. Utilize part 27 certificated T3 helicopters or better. Establish trigger points to stop operations.	Remote	Catastrophic	Serious
	Mountainous Terrain	Frequent	Catastrophic	High	Ensure Pilot is trained, experienced & qualified/carded. Non-local flight crews obtain thorough briefing on local conditions before starting operations. Aircraft appropriate for the mission. Performance planning is completed for environmental conditions. Consider dual pilot operations or utilize a mentor pilot for low experience pilots.	Remote	Catastrophic	Serious
	Urban Interface: Wires, General Aviation Traffic, Major Airport Traffic, Communications, Congestion, High Complexity	Probable	Catastrophic	High	Conduct thorough briefings. Review/establish Interagency agreements. Provide preseason briefing for Media aircrews. Preplan dipsites, staging area, helispots, etc. Update aerial hazard maps. Establish TFRs & issue NOTAMs as appropriate. Require dipsite management. Order/utilize aerial supervision (HLCO). Perform Airspace deconfliction and coordination. Provide frequency and airspace management training. Complexity is managed at appropriate level.	Remote	Catastrophic	Serious
Communications	Lack of Compatibility (Banding/Frequencies)	Probable	Critical	High	Utilize Unified Command. Review/establish interagency agreements to reduce/eliminate compatibility issues. Continue education/training.	Remote	Critical	Medium
	Frequency management - lack of timely response for Incident Support to obtain additional frequencies.	Probable	Critical	High	Evaluate prior reviews and conduct additional national Interagency reviews of frequency management. Release frequencies back to NICC as soon as they are no longer needed. Encourage Dispatch offices to order additional frequencies early in emerging incidents.	Occasional	Critical	Serious
	Cockpit overload	Frequent	Critical	High	Encourage pilots to speak up when starting to get overloaded. Discuss safety options with the pilot. Practice division of workload and CRM on incidents and in simulations.	Occasional	Critical	Serious
	Inadequate briefing	Occasional	Critical	Serious	Stress to Managers & Pilots the need to slow down & ensure adequate briefings. Follow Policy and guidelines, use existing checklists (IHOG, IRPG, etc) as a minimum. Solicate feedback, reiterate information given, use of maps, IAPS, and frequency lists. Ensure AARs are being conducted and documented.	Remote	Critical	Medium

Helicopter System - Operations - Continued								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Training	Lack of training for specialized missions i.e. rehab (Bale dropping, waddle placement), guzzler placement, etc.	Occasional	Critical	Serious	Consider and encourage using End Product Contracts. When end-product is not feasible, develop standardized description of how to sling unusual items. Develop a source list for approved equipment. Utilize PASPs. Utilize subject matter experts. Use "Tech Tips" to share information/procedures.	Remote	Critical	Medium
	Lack of standardized training with non-Federal cooperators (non-standard terminology, target description, resource capability & limitations)	Probable	Critical	High	Promote joint training with non-Federal cooperators. Ensure thorough briefings are conducted prior to starting operations. Check Incident Qualification cards.	Remote	Critical	Medium
Human Factors	Lack of Crew Resource Management (CRM)	Probable	Critical	High	Training, Brief/debrief, maintain positive attitude. Promote and attend formalized CRM training for contractors as well as agency employees. Include CRM training/topics at Helicopter Manager Workshops (RT-372). Include CRM as part of the training curriculum for S-372.	Occasional	Critical	Serious

System Safety Assessment - Rappel

Rappel System - Aircraft

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Adequate Screening/Evaluation	Lack of Standardization	Frequent	Critical	High	Develop National Rappel Standards/Evaluation Board.	Remote	Critical	Medium
	Aircraft perform near limits of capabilities due to mission, payload, and environment	Occasional	Catastrophic	High	Create national rappel specifications template for Schedule B. Utilize SMEs - Helicopter managers/HOSs/rappel specialists when developing aircraft contract specifications/modifications	Remote	Catastrophic	Serious
Performance, Capabilities, Limitations	Operating close to performance limitations of aircraft (weight/balance, DA, height/velocity curve, CG)	Frequent	Catastrophic	High	Strict compliance with flight manual and increased awareness training of aircraft performance for helicopter managers and proper mission planning. Continue using high performance Type 2 Helicopters and Part 27 Type 3 Helicopters.	Remote	Critical	Medium
	Pilot visibility/vertical & horizontal reference.	Occasional	Critical	Serious	Develop National screening/evaluation process, identify minimum standards for visibility in rappel aircraft	Remote	Critical	Medium
	Pilot moving from right to left seat to fit mission in Bell medium helicopters.	Occasional	Critical	Serious	Ensure that Schedule B contract language is standardized Nationally for Type 2 Helicopters.	Remote	Critical	Medium
Equipment	Rappel anchor failure	Remote	Catastrophic	Serious	Ensure anchor is approved with proper & valid STCs, tested annually, installed correctly, and inspected at manufacturer's recommendations.	Improbable	Catastrophic	Medium
	Spotter anchor failure	Occasional	Catastrophic	High	Ensure anchor is approved with proper & valid STCs, tested annually, installed correctly, and inspected at manufacturer's recommendations.	Improbable	Catastrophic	Medium
	Aircraft modifications improperly installed/false documentation	Remote	Catastrophic	Serious	Thorough maintenance inspections, verification of STC documentation and compliance, increased training for helicopter managers.	Improbable	Catastrophic	Medium
	ICS communications not available to all rappellers	Occasional	Critical	Serious	National rappel template for Schedule B.	Improbable	Critical	Medium
Communications	Spotter cannot independently manipulate FM radios from back seat (pilot task saturation)	Occasional	Critical	Serious	Audio panel conveniently available for pilot and spotter to individually manipulate.	Remote	Critical	Medium
Configuration	Doors off flight; crash survivability	Remote	Catastrophic	Serious	Minimize doors off operation to essential missions only, create doors off checklist for IHOG and IHRG.	Improbable	Catastrophic	Medium
	Doors off flight; non secured items	Remote	Catastrophic	Serious	Training on proper storage of equipment when flying with doors off. Create doors off checklist for IHOG and IHRG.	Improbable	Catastrophic	Medium
	External basket security	Remote	Catastrophic	Serious	Assure security of external loads prior to mission.	Improbable	Catastrophic	Medium

Rappel System - Equipment								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Maintenance	Lack of compliance with AD's, manufacture's inspections	Remote	Catastrophic	Serious	Strict compliance with flight manual, increased awareness training of maintenance requirements and AD's for helicopter managers, spot inspections of aircraft. Recommend all rappel contract helicopters require a mechanic.	Improbable	Catastrophic	Medium
Aircraft Health	Undetected corrosion, stress crack, structural. limited, and/or unknown amount of aircraft health testing and monitoring being performed on current aircraft (fatigue, corrosion, airframe, etc.)	Remote	Catastrophic	Serious	Ensure Maintenance Inspectors are conducting thorough reviews of aircraft maintenance logs	Improbable	Catastrophic	Medium
Common factors	Misuse/mistreatment	Occasional	Catastrophic	High	Education, supervision for following equipment use standards. When in doubt about equipment's usage, retire it.	Remote	Catastrophic	Serious
	Use of non-standard equipment	Occasional	Critical	Serious	Maintain current equipment standards for rappel equipment, only utilize approved rappelling equipment, random peer inspections	Remote	Critical	Medium
	Improper inspections	Occasional	Catastrophic	High	Education, supervision for following equipment inspection standards (IHRG)	Remote	Catastrophic	Serious
	Improper rigging	Occasional	Catastrophic	High	Proper training. Standardization. Maintain currency, proficiency, checks and balances. Place photos of correct model specific rigging on national rappel website and in IHRG.	Remote	Catastrophic	Serious
	Inconsistent documentation	Occasional	Critical	Serious	Education, supervision for following equipment documentation standards, random inspections. Utilize rap records database.	Remote	Critical	Medium
	Not following established procedures/policy	Occasional	Critical	Serious	Peer monitoring, annual base reviews, accountability at all levels for compliance, follow-up of action items. Mandatory attendance of spotters to biennial rappel workshop or rappel academy.	Remote	Critical	Medium
Spotter tether/Gunner strap	Improper adjustment	Occasional	Critical	Serious	Initial set-up of gunner straps and spotter tethers for specific model aircraft, pre-mission check. Post photos of correct adjustments on national rappel website and IHRG.	Remote	Critical	Medium
Research & Development	Improper use of newly approved equipment or during testing phase.	Occasional	Catastrophic	High	Education, training, documentation, thorough field testing in mutiple platforms and obtain feedback from field users. If one component of the system gets changed, the entire system needs to be re-evaluated.	Remote	Catastrophic	Serious
Cargo delivery system	No standard configuration	Frequent	Critical	High	Identify and establish model specific configuration and procedures.	Remote	Critical	Medium
	Use of unapproved containers	Occasional	Marginal	Medium	Supervisors, managers ensure only approved containers are properly utilized. All approved equipment is posted on the MTDC website	Remote	Marginal	Medium
	Improper cargo restraint straps/cargo compartment netting (internal only)	Occasional	Critical	Serious	Establish minimum standard for cargo restraint straps and protective netting.	Remote	Critical	Medium

Rappel System - Operations								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Training	Non standard/inconsistent	Frequent	Marginal	Serious	Utilize joint training. Train the trainer to one standard.	Occasional	Marginal	Medium
Supervision	Not properly qualified for firefighting mission	Remote	Catastrophic	Serious	Ensure Spotter and firefighters adhere to qualifications outlined in the IHRG.	Improbable	Catastrophic	Medium
	Escape routes and safety zones not identified	Occasional	Catastrophic	High	Ensure Spotter and ALL firefighters have knowledge and location of safety zones, and escape routes prior to fast rope deployment.	Remote	Catastrophic	Serious
Rappel site selection	Poor site selection	Occasional	Catastrophic	High	Spotter training, develop national standard Spotter Training Handbook, CRM, depth of fire experience, minimal redcard qualification of single resource boss with ICT4 being preferred.	Remote	Catastrophic	Serious
Rappel procedure	Non-standard procedures / policy deviation	Occasional	Catastrophic	High	Frequent unscheduled inspections by HOS/check spotter/peers/SME, suspend operations until corrections are made. Violations will result in program suspension. Utilize joint training when practical. Check spotters from other bases and regions will conduct combined training. Attendance of National or Regional Rappel Spotter Workshop is mandatory every two years.	Remote	Catastrophic	Serious
	Non-standard verbiage, direction, and interaction between spotter and pilot during rappel operations	Frequent	Critical	High	Increase simulation training, mock-ups, and proficiency (especially with relief pilots). Ensure proper briefing for new/relief personnel. Develop Challenge and Response criteria between spotter and pilot. Develop CRM training specific to pilot-spotter relationship to be included in IHRG or 310-1.	Remote	Critical	Medium
	Deviation from intended mission with limited information	Frequent	Critical	High	Obtain necessary information prior to accepting mission, obtain frequencies, contacts, coordinates, additional aircraft, known hazards, deconflict airspace, follow all FTA procedures. Ensure crew is "re-briefed" on new mission.	Occasional	Critical	Serious
	Exposure to off site landing	Frequent	Critical	High	Follow standard procedures (high-low recon, power checks, verify load calculations as valid, etc.) Follow risk management process. Site selection needs to be mutually agreed upon by pilot and spotter. Respond to the incident configured to rappel when appropriate.	Occasional	Critical	Serious
External cargo letdown	Rappellers on board helicopter during delivery of cargo which translates to longer exposure to personnel during high power settings in hover	Frequent	Critical	High	Follow standard procedures (high-low recon, power checks, verify load calculations as valid, etc.) Follow risk management process. Site selection needs to be mutually agreed upon by pilot and spotter. Respond to the incident configured to rappel when appropriate.	Occasional	Critical	Serious
	Overflying highways, major population area, personnel	Occasional	Critical	Serious	Establish and brief on proper flight paths, update maps, see and avoid, find other means for mission	Remote	Critical	Medium

Rappel System - Operations (Cont.)								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Internal cargo letdown	Security of Cargo without appropriate or approved hardware	Frequent	Critical	High	Establish minimum standard for cargo restraint straps and protective netting.	Remote	Critical	Medium
	Exposure to rappellers during internal load operations due to additional weight on board the aircraft and denied living space	Frequent	Critical	High	Consider performing cargo operation seperately. Ensure that method of securing cargo is adequate for the size and weight of the cargo in the event of an accident. When possible secure the cargo outside of the passenger compartment. Limit internal cargo weight. Require DOT approved containers for hazardous materials.	Occasional	Critical	Serious
Emergency Procedures	Lack of adequate training / Proficiency	Occasional	Critical	Serious	Increase simulation training, utilize tower/elevated platform to increase rappeller / spotter emergency procedure proficiency, develop training which includes pilot, spotter and rappeller. Improve / update spotter/rappeller training syllabus.	Remote	Critical	Medium
	Non standard verbiage for mission critical / non-critical situations (Emergency vs. Non-Emergency "in hover" during rappel ops)	Occasional	Critical	Serious	Increase simulation training, fund and utilize current simulators at McClellan, develop challenge/response criteria between spotter and pilot	Remote	Critical	Medium

System Safety Assessment - External Loads

External Load System - Aircraft

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Visibility	Pilot visibility, vertical/horizontal reference	Occasional	Critical	Medium	National screening/evaluation process, identify standard for visibility	Remote	Critical	Medium
	Placement of gauges and warning lights in cockpit does not allow pilot to monitor quickly and easily while looking down at load	Frequent	Catastrophic	High	National screening/evaluation process, identify standard for placement of gauges	Remote	Catastrophic	Serious
	Pilots inability to see the load due to aircraft design limitations	Occasional	Critical	Serious	Consider modifications to aircraft to improve pilot visibility i.e.; bubble window, floor window. Utilize proper mission planning and aircraft selection for the mission.	Remote	Critical	Medium
	Pilot moving from right to left seat to fit mission in Bell medium helicopters without shutting down	Remote	Critical	Medium	Enforce contract language regarding shut down before pilot exiting the aircraft.	Improbable	Critical	Medium
	Location of aircraft controls and switches not consistent, not standardized	Occasional	Critical	Serious	Establish standard configuration in helicopter contracts.	Remote	Critical	Medium
Doors off flight	In-flight exposure to environmental conditions	Occasional	Marginal	Medium	Provide appropriate clothing for weather conditions for occupants.	Remote	Marginal	Medium
Aircraft Equipment	Belly hook/remote hook not standardized	Occasional	Marginal	Medium	Familiarize crews with specific equipment. Cargo personnel should be briefed on equipment and aircraft to be used. (i.e. training and cross training on different hook types).	Remote	Marginal	Medium
	Non-standard ring size	Occasional	Critical	Serious	Ensure rings are compatible with specific helicopter rigging. Reference flight manual, and manufacturer data. Recommend hook placarding identify proper ring sizes.	Remote	Critical	Medium
	Cargo hook/remote hook failure leading to dropped load or inability to release load	Remote	Critical	Medium	Follow manufacturer's inspection and maintenance procedures. Check for proper operation before every mission.	Improbable	Critical	Medium
	Failure of electrical connection or electrical disconnect	Frequent	Critical	High	Inspect equipment and check for proper operation before every mission. Research and develop design for new, more reliable electrical connection system.	Occasional	Critical	Serious
Performance, Capabilities, Limitations	Operating outside design limitations of aircraft (weight/balance, DA, Height)	Probable	Catastrophic	High	Strictly comply with approved flight manual. Increase awareness of aircraft performance by training Helicopter Managers in proper mission planning.	Occasional	Catastrophic	High
	Pilot visibility/vertical & horizontal reference.	Occasional	Critical	Serious	Develop National screening/evaluation process. Identify minimum standards for visibility in rappel aircraft.	Remote	Critical	Medium
	Pilot moving from right to left seat to fit mission in Bell medium helicopters.	Occasional	Critical	Serious	Ensure that Schedule B contract language is standardized Nationally for Type 2 Helicopters.	Remote	Critical	Medium
Aircraft Health	Limited and/or unknown amount of testing and monitoring being performed on current airframe (fatigue, corrosion, etc)	Remote	Catastrophic	Serious	Ensure maintenance inspectors are conducting thorough reviews of aircraft maintenance logs.	Improbable	Catastrophic	Medium

External Load System - Operations

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Communications	Lack of positive communication due to frequency overload, wrong frequencies	Frequent	Critical	High	Proper mission planning, effective frequency management, and thorough briefing / debriefings, better utilization of Helicopter Coordinators, commo checks prior to departure.	Occasional	Critical	Serious
	Poor communications from ground to aircraft (background noise)	Frequent	Critical	High	As a minimum, increase the use of available communication cords from handheld radios to flight helmets, or handhelds to headsets. This should be required at all helibases that have a high volume of cargo operations.	Occasional	Critical	Serious
	Lack of common terminology	Occasional	Marginal	Medium	Utilize IAT website as a training tool (update on-line course if necessary). Stress use of common terminology during training and in briefings.	Remote	Marginal	Medium
Human Factors	Pilot/agency personnel fatigue	Probable	Catastrophic	High	Prioritize missions, evaluate risk vs. benefits. Consider rescheduling missions, avoid unnecessary flights, utilize optional days off as needed/requested. Promote open & honest communications regarding fatigue levels.	Remote	Catastrophic	Serious
	Lack of depth perception due to pilot not wearing prescription lenses	Occasional	Catastrophic	High	Brief with pilot on status of vision.	Remote	Catastrophic	Serious
	Pilot unfamiliar with aircraft	Probable	Critical	High	Utilize pilot check in process. Allow adequate time for pilot transitions. Address with Contractors via the CO.	Occasional	Critical	Serious
	Pilot unfamiliar with mission	Probable	Critical	High	Conduct proper briefings, encourage incident orientation flight. Utilize Helicopter Coordinators for pilot familiarization. Consider using a second pilot or mentor pilot for orientations.	Occasional	Critical	Serious
	Ergonomics; aircraft not configured well (bubble window, adjustable seating, etc.)	Occasional	Critical	Serious	Consider using a screening and evaluation board to assess the issue. Use appropriate flight crew and aircraft for the mission.	Remote	Critical	Medium
	Selection of aircraft inadequate for mission	Occasional	Critical	Serious	Improve education of key personnel on helicopter capabilities and limitations. (i.e. Update on-line IAT courses.) Obtain critical mission information from ground personnel, ATGS, HLCO. Select appropriate aircraft and pilot for mission via risk analysis.	Remote	Critical	Medium
In-flight Hazards	Controlled flight into towers, wires, trees, etc. (Aerial hazards) with external load.	Occasional	Catastrophic	High	Post updated hazard map(s), communicate with field personnel/pilots for additional hazard map updates. Always perform high level reconnaissance before transition to low level operations. Use extreme caution when diverted from intended mission/known flight paths. Utilize Helicopter Coordinators.	Remote	Catastrophic	Serious
	Other aircraft, congested airspace	Frequent	Catastrophic	High	Perform proper mission planning and utilize see and avoid tactics overcongested areas. Order airspace coordinator earlier. Ensure that TFRs are practical/realistic for the incident, are validated for each operational period, and are adjusted as needed. Require TCAS in all aircraft. Ensure pilots are checking NOTAMs for TFRs. Establish flight routes over incidents. Ensure appropriate level of aerial supervision is in place and there is compliance with FTA protocols. Follow boundary fire protocols/plans. Coordinate early and often with military.	Remote	Catastrophic	Serious

External Load System - Operations (cont.)

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
In-flight Hazards (Cont)	Dropped load in congested area	Remote	Catastrophic	Serious	Utilize updated hazard maps in briefings. Establish flight paths. Helibases and cargo areas should be established in areas to minimize flights over congested areas with external loads. Utilize alternative methods of cargo transport.	Improbable	Catastrophic	Medium
	Unstable load during flight	Occasional	Catastrophic	High	Improve crew training on load preparation/assembly. Prepare cargo correctly using approved equipment. Consider and use other means of transport when possible (ground, internal cargo). Standardize procedures for recurring missions.	Remote	Catastrophic	Serious
In-flight Hazards	Overgross load	Occasional	Critical	Serious	Ensure proper mission planning (i.e. proper performance planning, load calculations, manifesting). Improve training through A-219. Utilize load cell.	Remote	Critical	Medium
	Inappropriate length of line for mission	Probable	Catastrophic	High	Better mission planning, better site assessment, improve training through A-219. Follow IHOG standards for site selection & rotor clearance. Ensure thorough communications from the field/incident to the helibase and from the helicopter to the ground personnel.	Remote	Catastrophic	Serious
	Poor visibility due to smoke, sun, shadows	Occasional	Critical	Serious	Time missions for optimal visibility, obtain feedback from on-site personnel and pilots regarding conditions, utilize aerial supervision, Stress that sunrise/sunset charts are minimums.	Remote	Critical	Medium
Ground Hazards	Dragged load	Frequent	Critical	High	Provide for pilot proficiency while on contract, improve the carding process for approving external load operations. Ensure site is adequate. Monitor fatigue.	Occasional	Critical	Serious
	Personnel too close to drop site	Occasional	Critical	Serious	Provide pilot with ground contact. Improve utilization of Helicopter Coordinators. Provide training for ground personnel to emphasize hazard identification and communication methods.	Remote	Critical	Medium
	Inexperienced ground personnel	Probable	Critical	High	Check qualifications prior to mission acceptance, provide additional pre-season training (A-219).	Occasional	Critical	Serious
	Snagged load (net, bucket)	Occasional	Catastrophic	High	Better site evaluation and preparation, trained personnel at site for positive communication with pilot.	Remote	Catastrophic	Serious
	Rotor wash, falling snags	Occasional	Catastrophic	High	Improve process of site evaluation and preparation. Utilize trained personnel at site for positive communication with pilot.	Remote	Catastrophic	Serious
	Pilot unfamiliar with dipsite, sling spot	Frequent	Critical	High	Conduct proper pre-mission briefing. Improve utilization of Helicopter Coordinators.	Occasional	Critical	Serious
	Unsecured load on steep terrain	Occasional	Critical	Serious	Ensure experienced personnel are at the site, develop approved tag line(s) for some equipment (blivet)	Remote	Critical	Medium
	Cable or line inadvertently placed over skid	Occasional	Catastrophic	High	Mitigation possible through better raining, increased experience, and good communications with pilot during preflight checks. Emphasize thorough visual aircraft safety walk around and checks by ground personnel prior to flight.	Remote	Catastrophic	Serious
	Working in close proximity to hovering helicopter	Frequent	Critical	High	Better site evaluation and preparation, trained personnel at site for positive communication with pilot.	Occasional	Critical	Serious
	Poor site selection	Occasional	Critical	Serious	Improve utilization of Helicopter Coordinators to assist ground personnel. Don't utilize aircraft if site can't be improved or relocated.	Occasional	Critical	Serious

External Load System - Operations (cont.)

Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Equipment	Component failure resulting in dropped load	Remote	Catastrophic	Serious	Ensure contractor equipment meets requirements under Part 133, agency personnel need to inspect and maintain all rigging equipment.	Remote	Catastrophic	Serious
	Snorkel snagged on object	Remote	Catastrophic	Serious	Utilize experienced dipsite managers whenever possible, encourage managers to approve site, perform high recon. Ensure dip tanks are clean of hardware that may cause snag.	Remote	Critical	Medium
	Non standard or approved method of securing cargo to steep terrain	Probable	Critical	High	Use approved tag lines for blivets.	Occasional	Critical	Serious
Training	Inadequate pilot longline proficiency	Frequent	Catastrophic	High	Provide opportunities and funding for pilot proficiency flights while on contract.	Occasional	Catastrophic	High
	Lack of experience	Frequent	Catastrophic	High	Implement longline training school, contractor mentoring program, use of simulators, etc.	Occasional	Catastrophic	High
	Pilots with little experience being qualified for external load operations	Frequent	Catastrophic	High	Hold contractors accountable to what is stated in the Vertical Reference Standards located in the national contract. Additional Helicopter Inspector pilots may be needed to ensure contractors meet these standards. Pilot(s) should NOT be issued a card unless these standards are being met.	Remote	Critical	Medium
Environment	High wind or poor visibility	Occasional	Catastrophic	High	Increase the use of Helicopter Coordinators. Establish trigger points and shut down missions early if necessary. Treat IHOG standards as limits. Limit or stop operations before limits are met or exceeded. Receive briefing on local weather and wind conditions to encourage proactive decision making.	Remote	Catastrophic	Serious
	Flight routes not identified	Occasional	Catastrophic	High	Improve use of Helicopter Coordinators. Require better maps at Helibases and in IAP's. Allow for input and concurrence from pilots at briefings. Utilize Airspace Coordinators as necessary.	Remote	Catastrophic	Serious
Hover Hookups	Working in close proximity to hovering helicopter	Frequent	Critical	High	Minimize exposure (only personnel essential to the mission should be in area) Use proper ---- Develop, brief, and utilize emergency egress procedures when working under hovering helicopter.	Occasional	Critical	Serious
	Damage to aircraft (antenna, bubble)	Remote	Marginal	Medium	Brief personnel on aircraft	Remote	Marginal	Medium
Emergency Procedures	No established procedure for extracting critically injured personnel as an external load with contracted aircraft	Frequent	Catastrophic	High	Develop a standard procedure for extracting critically injured personnel.	Remote	Catastrophic	Serious

External Load System - Loading								
Sub-System	Hazards	Pre-mitigation			Mitigation	Post-mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Training	Inconsistent training among interagency personnel (exclusive use vs. CWN helitack, handcrew, hotshot, smokejumpers, etc.). Using untrained or unqualified personnel.	Frequent	Critical	High	Fully implement IAT A-219 course. Provide training to appropriate supervisory and key personnel. External load operations should be supervised by trained personnel.	Occasional	Critical	Serious
	Unfamiliarity with specific aviation BAER projects (rigging, procedures, equipment)	Occasional	Critical	Serious	Utilize experienced helitack personnel to assist with preplanning, mission planning and implementation of project. Provide training specific to new equipment and procedures. Verify that all equipment and procedures are approved. Use SME's when implementing projects.	Remote	Critical	Medium
	Inconsistent inspections and improper repair of rigging equipment	Occasional	Critical	Serious	Follow manufacturers' maintenance requirements. Post inspection sheets where equipment is stored. Perform pre-use inspection of equipment. Remove any damaged/faulty equipment from use.	Remote	Critical	Medium
Equipment	Use of unapproved equipment for flying loads that won't fit in a net	Occasional	Critical	Serious	Use only proper and approved equipment for flying external loads. Consider other ways to accomplish the mission and avoid making hasty, poor decisions under pressure to get the job done.	Improbable	Critical	Medium
	Inability to weigh some cargo items due to size, shape	Probable	Critical	High	Evaluate alternative scales through market research, procure/evaluate new products, and make them available for helicopter cargo operations.	Occasional	Critical	Serious
Human Factors	Estimating cargo weights	Probable	Critical	High	Provide appropriate scales, allow adequate time to prepare loads for missions. Rely upon standard equipment weight lists. When in doubt overestimate weights. Do not fly loads if weights cannot be adequately determined.	Occasional	Critical	Serious
	Changing priorities and weights	Probable	Critical	High	Conduct better mission planning. Be flexible for changes and anticipate/plan for most reasonable occurrences.	Occasional	Critical	Serious

System Safety Assessment - Heavy Airtanker Program

Heavy Airtanker Program System - Airworthiness

Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Operational Service Life	Forest Service has not historically conducted airworthiness inspections; it has relied upon the FAA for that expertise. The perceived role was one of contract compliance.	Remote	Catastrophic	Serious	Continue contractual requirements commensurate with industry standards required by FAR 25.571 for aircraft continued airworthiness. Incorporate the latest inspection technology.	Remote	Marginal	Medium
	Forest Service has not identified metrics that define the fire environment for the purpose of establishing effects on airworthiness.	Remote	Catastrophic	Serious	Employee additional workforce with the skills to determine airworthiness.	Remote	Marginal	Medium
Maintenance and Inspections	Overloading Structure	Remote	Catastrophic	Serious	Encourage the design and procurement of purpose built aircraft. Incorporate the latest inspection technology.	Remote	Marginal	Medium
	Engine Failures	Probable	Marginal	Serious	Changing to turbine engines.	Remote	Marginal	Medium
Airframe Fatigue Damage	The NTSB surmised that significant exposure to airframe stresses in the firefighting mission profile poses additional fatigue factors that shorten airframe life expectancy.	Remote	Catastrophic	Serious	Incorporate structural health monitors and technologies to detect structural fatigue damage resulting from aircraft operations in the firefighting mission environment.	Remote	Marginal	Medium

Heavy Airtanker Program System - Contract Process

Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Cost	Current contracting fosters best value process which guarantees only minimum standards.	Frequent	Critical	High	Incorporate addition contract incentives that give credit in the competition process for going "beyond minimum programs".	Remote	Marginal	Medium
	Lack of contract incentive to develop a system safety driven program	Frequent	Critical	High	Incorporate addition contract incentives that give credit in the competition process for going "beyond minimum programs".	Remote	Marginal	Medium
	Modernization of the airtanker fleet will take significant funding. As new equipment is brought into the mix of aircraft, unplanned events are inevitable. The agency does not have the skill mix to oversee flight testing and development in house.	Occasional	Catastrophic	High	Implement airtanker modernization and evaluation criteria in best value contracts including but not limited to: performance, sustainable airframes, ergonomics, additional contractor offered innovation and technology, damage tolerant design and technology	Remote	Catastrophic	Serious

Heavy Airtanker Program System - Mission Environment

		Pre Mitigation			Mitigation	Post mitigation		
Sub-systems	Hazards	Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Performance Planning	Quality of performance data and reference charts at typically high density altitudes is a concern for safe flight in the fire mission environment.	Probable	Catastrophic	High	Develop a contract requirement for airtanker pilots to complete weight and balance calculations prior to each mission.	Remote	Critical	Medium
Flight Profile	Mission operations below 500' AGL.	Probable	Catastrophic	High	Incorporate human aided technology to assist in decision making including tools to aid in time critical risk assessments. Adapt technology for in flight decision making, post flight mission debriefs, and accident investigation. Consider CVR and cockpit d	Remote	Critical	Medium
Mission Creep	Operations in the urban interface have led to an increase in expectations, exposure to hazards, and cumulative aircraft and pilot fatigue.	Probable	Catastrophic	High	Return to the initial attack mission doctrine as a driving force in aircraft selection and approval, operations standards, and program/infrastructure design.	Remote	Critical	Medium
	Transfer of risk from ground firefighters to airborne firefighters.	Probable	Catastrophic	High	Return to the initial attack mission doctrine as a driving force in policies that govern the airtankers role in wildland fire suppression.	Remote	Critical	Medium

Heavy Airtanker Program System - Facilities

		Pre Mitigation			Mitigation	Post mitigation		
Sub-systems	Hazards	Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Tanker Bases	Overloading and mixing errors	Occasional	Critical	Serious	ensure micro motion meters have been calibrated. Vendor and government personnel review mixing procedures.	Remote	Marginal	Medium

Heavy Airtanker Program System - Ground Fire Personnel

		Pre Mitigation			Mitigation	Post mitigation		
Sub-systems	Hazards	Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
	Use of tankers for escaped fire situations has increased risk, exposure, and failure. This issue rests outside of the control of the aviation program.	Probable	Critical	High	National leadership through regional/state organizations must promote safe and efficient use of aircraft. Incident Commanders at all levels need to be persistent in working with team members to keep efforts based on obtainable goals.	Remote	Marginal	Medium

Heavy Airtanker Program System - Human Factors

		Pre Mitigation			Mitigation	Post mitigation		
Sub-systems	Hazards	Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Pilot Proficiency and Training	Lack of fire mission training and Lack of proficiency flight time.	Probable	Catastrophic	High	Vendors have instituted training programs such as CRM, risk management, and flight safety with the intent to standardize cockpit procedures. Increase the scope and complexity of the NAFA program, develop the McClellan training center for fire environment	Occasional	Critical	Serious
	Aircraft performance planning for successful outcome in a high rate of descent, level off, and climb out profile.	Probable	Catastrophic	High	Address airtanker pilot training and proficiency to reduce frequency of accidents occurring from CFIT.	Occasional	Critical	Serious
	High number of target fixation and tactical maneuvering errors.	Probable	Catastrophic	High	Address human factors including target fixation, situational awareness, task overload, performance/tactical planning errors.	Occasional	Critical	Serious

Heavy Airtanker Program System - Policy, Procedure, and Doctrine								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Management Oversight	No requirement to implement a system safety program that is common between the contractor and the agency.	Probable	Catastrophic	High	Establish a requirement to initiate a safety management system between the contractor and the agency. Require the contractor to designate a safety officer.	Remote	Marginal	Medium
Agency Culture	"Can do" philosophy has developed aviation programs with minimal budgets and staffing.	Probable	Critical	High	The Blue Ribbon Panel stated: "significant funding will provide adequate knowledge of aircraft conditions, training and maintenance, that will serve to improve the safety record".	Remote	Marginal	Medium
	A culture of acceptable loss has evolved in the agency regarding airtanker losses.	Probable	Critical	High	Establish a higher expectation beyond minimum requirements for safety with a lower tolerance for accidents. This will encourage a cultural change away from one of acceptable loss.	Remote	Marginal	Medium
Quality Assurance and Inspections	Lack of an operative quality assurance and inspection program.	Probable	Critical	High	Develop a QA program for improved oversight of the contracted fleet ranging from improved checkrides, workforce efficiency, adequate staffing of trained inspectors, and standardized procedures.	Remote	Marginal	Medium
Public Perception	Influence on the agency	Probable	Marginal	Serious	Establish doctrine	Remote	Marginal	Medium
Heavy Airtanker Program System - Technology								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Human Aided Technology	HAT underutilized	Occasional	Critical	Serious	Incorporate HAT with the intent to raise situational awareness, reduce cockpit workload, reduce distractions, and assist with environmental conditions of high density altitude and low visibility.	Occasional	Marginal	Medium
Heavy Airtanker Program System - Training								
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Internal	Pilot currency and proficiency.	Occasional	Critical	Serious	Increase the scope and complexity of NAFA and require tanker crew attendance. Fund the development and implementation of fire simulation training in the flight environment for contract and agency personnel.	Occasional	Marginal	Medium
External	Pilot currency and proficiency	Occasional	Critical	Serious	Increase the scope and complexity of NAFA and require tanker crew attendance. Fund the development and implementation of fire simulation training in the flight environment for contract and agency personnel.	Occasional	Marginal	Medium

System: Aircraft		2008 Infrared Program Assessment							
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation			
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome	
Avionics	Loss of electrical power	Remote	Critical	Medium	Keep your cell phone handy (and charged up), Have the required 2 "D" cell flashlight working and charged, Have a spare hand-held VHF-AM radio, Training on emergency procedures	Remote	Critical	Medium	
	Erroneous read-outs from the equipment	Occasional	Critical	Serious		Training, Pre and post season avionics checks	Remote	Marginal	Medium
	Non-Standard (type/layout/location) of equipment	Frequent	Critical	High		Update the equipment/design for standardization & Train to the new equip. & Maintain currency in all A/C, Standardize fleet to same make aircraft	Improbable	Marginal	Medium
IR Equipment	Electrical Interface (A/C Mods)	Frequent	Negligible	Medium	Coordinate with all staffs on modifications prior to the installations, Refresher (preseason) mission training and equipment calibration	Occasional	Negligible	Low	
	Increased exposure to land/take-off to hand-off imagery	Frequent	Critical	High		Install and utilize satellite up-link capability	Occasional	Critical	Serious
Maintenance	Nitrogen servicing (Improper technique), not wearing proper PPE and ultimately causing personal injury	Frequent	Marginal	Serious	Proper training/procedures	Frequent	Negligible	Medium	
	Maintenance providers (lack of skilled technicians/repair stations)	Occasional	Catastrophic	High	Coordination with maintenance personnel and repair stations	Remote	Catastrophic	Serious	
	Undocumented open discrepancies	Occasional	Marginal	Medium	Follow SOPs	Improbable	Marginal	Medium	
	Not performing Functional Check Flight (FCF) before releasing aircraft after maintenance (when applicable)	Remote	Catastrophic	Serious	Perform FCFs when applicable, coordinate with maintenance technician; if possible take maintenance technician on FCF	Improbable	Critical	Medium	
Standarization	Non-Standard Aircraft	Frequent	Critical	High	Update the equipment/design for standardization & Train to the new equip. & Maintain currency in all A/C, Standardize fleet to same make aircraft	Improbable	Marginal	Medium	
Modifications	Effects of modifications that decrease aircraft capabilities causing additional crew workload/exposure/performance issues(fuel burn, flight planning)	Frequent	Marginal	Serious	Correction to existing modification; coordination and testing of future modifications.	Remote	Negligible	Low	
	Increased exposure to mid-air collision due to necessity of turning off TCAS during mission because of interference between TCAS and IR equipment.	Frequent	Catastrophic	High	Testing and relocation of system components to correct the interference; for future modifications include testing for interface interference.	Improbable	Negligible	Low	
Fuel	Bad Fuel	Remote	Catastrophic	Serious	Observe fueling; sump fuel as required.	Improbable	Catastrophic	Medium	
	Improper fuel loading	Remote	Catastrophic	Serious	Observe fueling; confirm loading.	Improbable	Catastrophic	Medium	

System: Environmental		2008 Infrared Program Assessment						
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Weather	Flying in bad weather	Probable	Critical	High	Preflight planning, Just say NO (accept the fact that the mission cannot be completed)! PIREPS, Call local area, change priority of mission flight, Equip monitoring (i.e. Wx Radar, Storm scope, XM radio, etc...)	Occasional	Critical	Serious
	Pressure to complete the mission regardless of the Wx	Frequent	Critical	High	Just say NO! Education/Training of the ground personnel regarding go-no-go situations. Preflight planning. Give options.	Occasional	Critical	Serious
	Icing equipment (aircraft) failing	Remote	Marginal	Medium	Preflight checks of icing equipment, proper maintenance of icing equip.	Improbable	Marginal	Medium
	Smoke Column	Occasional	Critical	Serious	IR Technician reports, PIREPS, Debrief other fire air ops crews (lead plane, airattack, etc...) Fly out of column	Remote	Critical	Medium
Topography	Controlled flight into terrain	Improbable	Catastrophic	Medium	Maintain Situational Awareness, File IFR, Train and remain proficient	Improbable	Catastrophic	Medium
	Moderate (plus) turbulence	Occasional	Marginal	Serious	Preflight briefing, PIREPS, Fly different altitude or out of area	Remote	Marginal	Medium

System: Airports		2008 Infrared Program Assessment						
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Location	Mountainous Terrain-Unfamiliar, leading to CFIT,	Occasional	Catastrophic	High	Preflight planning, instrument approaches, refusal of delivery point, landing during daylight hours	Remote	Critical	Medium
	Collision with wildlife on the runways leading to damage/injury of personnel or property	Occasional	Critical	Serious	Perform fly-by, contact personnel on ground to check field, air-drop, install gun on nose of aircraft	Improbable	Critical	Medium
Limitations	Airport surface condition is not conducive to landing resulting in damage to aircraft	Remote	Critical	Medium	Check the AFD, NOTAMS, local traffic, Tower,	Improbable	Critical	Medium
	Runway length is not appropriate for the aircraft's capabilities	Occasional	Critical	Serious	Perform performance calculations/preflight planning, NOTAMS	Improbable	Critical	Medium
	construction hazards/equipment	Occasional	Critical	Serious	NOTAMS, ATIS, Local traffic, Tower, UNICOM	Improbable	Critical	Medium
IAP	Lighting systems are inop/inadequate leading to a short landing/go-around, CFIT	Remote	Catastrophic	Serious	ATIS UNICOM, visual cues, preflight planning	Improbable	Catastrophic	Medium
	Unfamiliar with the missed approach procedures (MAP), leading to CFIT	Remote	Catastrophic	Serious	Preflight planning. Performing approach briefings, training/proficiency, current charts, CRM	Improbable	Catastrophic	Medium
	Not having an IAP leading to a CFIT	Occasional	Catastrophic	High	Preflight planning. Performing approach briefings, training/proficiency, current charts, CRM, Do NOT land if conditions are such that it is unsafe to make a safe visual approach and landing	Improbable	Catastrophic	Medium
Airspace	Congested, task saturation of controller and/or pilots/crew, midair possibility	Remote	Catastrophic	Serious	TCAS, SA, CRM, Training, Communications, Chose another airport	Improbable	Catastrophic	Medium
	No Tower-pilots operating without radio or wrong frequency-Possible midair	Remote	Catastrophic	Serious	SA, communicattions, CRM, UNICOM, PIREPS, aircraft lighting, TCAS,	Improbable	Catastrophic	Medium
	Incursions on the runway and parking areas	Occasional	Critical	Serious	SA, CRM, TCAS, Communications, A/C lighting, training, parking tenders, familiar with the airport	Remote	Critical	Medium
Support Personnel	Unqualified Personnel (ground/ramp or agency) leading to misfueling, hazardous parking, leading to damage to the aircraft or injury to personnel	Occasional	Critical	Serious	SA, CRM, Communication, Training of support personnel	Remote	Critical	Medium

System: Personnel		2008 Infrared Program Assessment						
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Human Factors	Fatigue-Cronic, errors due to fatigue (SA)	Frequent	Critical	High	Scheduling management (reduce duty hrs and/or flight time), sufficient staffing levels , sleep-power naps, Training, CRM, support of crew decision to decrease duty day,	Remote	Marginal	Medium
	Fatigue-Acute, errors due to fatigue (SA)	Frequent	Critical	High	Training, CRM, sleep-power naps, support of crew decision to decrease duty day	Remote	Negligible	Low
	Trans-cockpit authority gradient, junior crewmember not confident in speaking up about a hazard	Occasional	Critical	Serious	Education/Training, CRM, communications, tailgate sessions/AAR (after action review, debrief)	Remote	Critical	Medium
	Mission pressure from management, leading to fatigue, harried decisions leading to hazardous mistakes	Frequent	Catastrophic	High	Training, CRM, Support of crew decisions, neutral person (arbitrator) to share issues/disputes/conflict resolution	Remote	Marginal	Medium
	Mission pressure from other factions (dispatch/fire teams), leading to fatigue, anxiety, harried decisions leading to hazardous mistakes	Frequent	Catastrophic	High	Education/training, attending the IMT/dispatch meetings, ensuring open communication between IMTs, dispatch and coordinators, AARs (debriefings)	Occasional	Marginal	Medium
	Stress and fatigue from insufficient staffing levels leading to the can-do/will-do attitudes	Frequent	Critical	High	Staff and budget at appropriate levels, support the crews decision to manage workloads that are commensurate with the staffing levels	Remote	Negligible	Low
	Logistical issues with non-co-located personnel leading to additional exposure of flight/landings/take-offs ultimately leading to fatigue/stress/damage/injury to the aircraft and or personnel	Frequent	Catastrophic	High	Co-locate personnel at single base/unit, RON at single location	Improbable	Negligible	Low
	Personnel dissention between factions of the IR "System" leading to stress and anxiety, resulting in degraded decision making and ultimately possible damage/injury to aircraft or personnel	Probable	Critical	High	CRM & teambuilding training for all IR systems staff; open communications; pre/post season meeting to include all factions of IR systems staff; AARs; clearly defined policies, procedures & roles (Infrared Operations Guide).	Improbable	Negligible	Low
Training	Unqualified personnel flying the aircraft-Resulting in: CFIT, emergency procedures, incidents, accidents	Occasional	Critical	Serious	Qualified and mission profecient personnel flying the aircraft, adequate staffing levels.	Improbable	Negligible	Low
	Unqualified IR technicians leading to damage to aircraft and/or personnel	Remote	Critical	Medium	Qualified and mission profecient personnel operating/maintaining the equipment.	Improbable	Negligible	Low
Medical	Flying with known physiological conditions leading to degraded decisions, and hazardous mistakes	Occasional	Critical	Serious	CRM, communications, training and education, take additional time off to recover, see the Doctor, support from other factions	Improbable	Negligible	Low
Night Ops	Accidents while driving to lodging after mission completion late at night.	Occasional	Critical	Serious	Use of shuttles, most alert crewmember drives	Remote	Critical	Medium
	Incidents or errors caused by physiological challenges (circadian rythem deviations, vision, fatigue)	Frequent	Catastrophic	High	Education and training; implement CRM; knowing and employing personal limitations	Occasional	Critical	Serious
Management	Lack of skilled leadership/managerial skills in supervisors and upper management leading to stress/anxiety of crews resulting in errors and/or degraded decision-making skills.	Probable	Critical	High	Leadership training, participation in pre/post meetings of IR system staff.	Remote	Marginal	Medium

System: Policy		2008 Infrared Program Assessment						
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
Duty Day	Fatigue-Cronic, errors due to fatigue (SA)	Frequent	Critical	High	Scheduling management (reduce duty hrs and/or flight time), sufficient staffing levels , sleep-power naps, training, CRM, support crew decision to decrease duty day	Remote	Marginal	Medium
	Fatigue-Acute, errors due to fatigue (SA)	Frequent	Critical	High		Training, CRM, sleep-power naps, support crew decision to decrease duty day	Remote	Negligible
Qualifications	Unqualified personnel flying the aircraft-Resulting in: CFIT, emergency procedures, incidents, accidents	Occasional	Critical	Serious	Qualified and mission proficient personnel flying the aircraft, adequate staffing levels.	Improbable	Negligible	Low
Ill-defined policy and procedures	Procedures that do not reflect the entire IR system leading to ambiguity in the decisions that need to be made, adding stress and anxiety to the crew's workload ultimately leading to hazardous decision making with possible damage/injury to aircraft or crew	Occasional	Critical	Serious	Clearly defined policies, procedures, and roles (Infrared Operations Guide); Have IR Ops Guide approved by line officer authority.	Improbable	Negligible	Low

System: Flight Operations		2008 Infrared Program Assessment						
Sub-systems	Hazards	Pre Mitigation			Mitigation	Post Mitigation		
		Likelihood	Severity	Outcome		Likelihood	Severity	Outcome
CWN/Other A/C	Use of uncarded aircraft and crew. Failure to follow policy/safety recommendations resulting in use of pilots who are not proficient or current for the mission. Using aircraft that may have exceeded inspection and or component replacement deadlines.	Occasional	Negligible	Low	Check aircraft data cards and pilot qualification cards	Improbable	Negligible	Low
Night Ops	Incidents or errors caused by physiological challenges (circadian rhythm deviations, impaired vision, fatigue)	Frequent	Catastrophic	High	Education and training; implement CRM; Recognize and operate within personal limitations.	Occasional	Critical	Serious
Communication	Losing radio communications	Remote	Negligible	Low	Carry back up hand-held radio in the survival kit; cell phones available	Remote	Negligible	Low
	Chance of striking person or property with drop tube because of a lack of clear communications during air drop	Occasional	Critical	Serious	Ensure clear communications prior to drop--no drop if no communications; follow established drop procedures	Improbable	Negligible	Low
Instrument Flying	Inadvertant flight into IMC Conditions	Remote	Marginal	Medium	Filing IFR; preflight planning; if you encounter IMC inadvertently fly instruments and exit IMC conditions	Improbable	Marginal	Medium
	Lack of currency and proficiency	Remote	Catastrophic	Serious	Maintain currency and proficiency; Do not allow non-current crewmembers to fly missions	Improbable	Catastrophic	Medium
	Controlled flight into terrain (CFIT)	Improbable	Catastrophic	Medium	Maintain situational awareness; training; file IFR	Improbable	Catastrophic	Medium
Airspace	Congestion, mid-air collision potential	Remote	Catastrophic	Serious	File IFR, TCAS, Situational awareness, visual scanning	Improbable	Catastrophic	Medium
	Non-radar/uncontrolled airspace-unknown aircraft, possible mid-air collision	Remote	Catastrophic	Serious	See and avoid, Use TCAS	Improbable	Catastrophic	Medium
Delivery of Imagery	Hot hand-offs resulting serious injury or death	Remote	Catastrophic	Serious	Ensure crew is adequately trained. Maintain Situational Awareness. Be sure communications are clear between air-ground personnel.	Improbable	Catastrophic	Medium
	Air drop tubes striking an object or person causing damage or personnal injury	Remote	Catastrophic	Serious	Ensure crew is adequately trained. Maintain Situational Awareness. Be sure communications are clear between air-ground personnel. employ data transfer via satellite, No communications-NO drop	Improbable	Catastrophic	Medium
	Low/slow flight profile in delivery of air drop resulting CFIT	Probable	Catastrophic	High	Training, Situational Awareness, CRM, clear and positive air to ground communications, IAPs, Use radio altimeter, Determine criteria for go-no go situations/decisions. Drop only during clear VFR conditions.	Remote	Catastrophic	Serious

Example

Risk Assessment Matrix

RISK ASSESSMENT MATRIX					
		Severity			
		Negligible	Marginal	Critical	Catastrophic
Likelihood					
Frequent					
Probable					High
Occasional				Serious	
Remote			Medium		
Improbable		Low			

Severity Scale Definitions	
Catastrophic	Results in fatalities and/or loss of the system.
Critical	Severe injury and/or major system damage.
Marginal	Minor injury and/or minor system damage.
Negligible	Less than minor injury and/or less than minor system damage.

Likelihood Scale Definitions		
Frequent	Individual Fleet	Likely to occur often. Continuously experienced.
Probable	Individual Fleet	Will occur several times. Will occur often.
Occasional	Individual Fleet	Likely to occur some time. Will occur several times.
Remote	Individual Fleet	Unlikely to occur, but possible. Unlikely but can reasonably be expected to occur.
Improbable	Individual Fleet	So unlikely, it can be assumed it will not occur. Unlikely to occur, but possible.

