Independent Risk Assessment For Personnel Transport In Type 1 Helicopters

Final Report

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Executive Summary

This report documents an independent risk assessment of the mission of transporting personnel in Type 1 helicopters in the wildfire environment excluding the additional hazards of transporting personnel in an initial attack role and rappelling. The project was conducted under contract to a team of consultants. It was accomplished during March and April 2009. The report and its conclusions are solely those of the consultants.

The consultants believe that personnel transport in Type 1 helicopters can be done with improved reliability and safety, but only with the successful implementation of mitigation measures that address the specific hazards posed by this mission. The conclusions stated below incorporate observations that the consultants documented in other recent consulting work with the Forest Service. The consultants suggest that Forest Service decision-makers, in assessing the appropriateness and effectiveness of mitigation measures, consider these conclusions.

Conclusion 1
Benchmarking the outcomes of this independent risk analysis against Forest Service expectations for program performance isn't attempted, as the Forest Service hasn't established risk acceptance standards and procedures for its aviation operations. Forest Service leaders need to determine the level of acceptable residual risk.

Conclusion 2
Transporting personnel in Type 1 helicopters is a mission, which has significant similarities to transport of personnel in Type 2 and 3 helicopters. However, there are some highly significant and important differences.

Conclusion 3
The SMEs were able to develop one or more mitigation measures for each identified hazard. Each mitigation measure reduced the outcome rating by at least one level. Some mitigation measures have a higher overall benefit versus cost than others.

Conclusion 4
Many of the mitigation measures that were developed were in response to hazards that often exist during personnel transport using Type 2 or 3 helicopters as well as in Type 1 helicopters.

Conclusion 5
The mitigation measures will either reduce the likelihood of a mishap or lessen the potential consequence of a mishap.

Conclusion 6
Many Forest Service positions are essential for the successful implementation of Type 1 helicopters for personnel transport missions and are vacant or are in critically short supply. These vacancies also exist in the support of other helicopter missions as well.

Conclusion 7

The mission of personnel transport in Type 1 helicopters grew from one to seven helicopters in recent years without a Program Review coupled with a Safety Management Systems analysis to identify the hazards and mitigation measures presented by this new mission and volume of business. This new mission involved significant changes for the contractors, some of whom had minimal experience transporting personnel, and for the Forest Service, which also had little experience performing this mission.

Conclusion 8

The significant increase in the number of exclusive use contract Type 1 and 2 helicopters and shift in their management to the national aviation operations office has greatly impacted the National Helicopter Program Manager and National Helicopter Operations Specialist positions.

Independent Risk Assessment
For Personnel Transport In Type 1 Helicopters

Introduction

This report documents an independent risk assessment of the mission of transporting personnel in Type 1 helicopters in the wildfire environment excluding the additional hazards of transporting personnel in an initial attack role and rappelling. The project, conducted under contract to the Forest Service (FS), was accomplished in March and April 2009. This independent risk assessment is produced by Fire Program Solutions, LLC, (FPS) in cooperation with PJKelly Consulting, LLC, and Safe Fire Programs, Inc., (consultants) with quality control, professional review and independent guidance from Baldwin Aviation, Inc. The report and its conclusions are solely those of the consultants.

The Forest Service provided a dedicated and highly professional group of subject matter experts (SME) who identified hazards and mitigation measures relating to the transportation of personnel with Type 1 helicopters. The SMEs included the National Helicopter Program Manager, the National Helicopter Operations Specialist, the National Airworthiness and Logistics Officer, the National Aviation Training Specialist and the Pacific Northwest Region's Aviation Operations Manager. These five individuals served as subject matter experts (SMEs) to identify hazards, mitigation measures, benefits and costs The consultants appreciate their professionalism and dedication to the pursuit of improvements to the Forest Service aviation program.

The scope of work left the choice of methodology to the consultants. The consultants chose to use the Safety Management Systems (SMS) as defined in the Federal Aviation Administration's (FAA) Advisory Circular 120-92 (Appendix J) and the 2008 (Forest Service) Systems Safety Aviation Guide (Appendix B) with modifications to fit circumstances unique to the Forest Service.

The scope of this independent risk assessment addresses the mission of personnel transport using Type 1 helicopters in the wildland fire environment. Many of the hazards and mitigation measures could apply to other Type 1 helicopter missions as well as missions performed by Type 2 and Type 3 helicopters. The SMEs project that three to ten exclusive-use Type 1 helicopters will be used for personnel transport annually in the foreseeable future. These three to ten helicopters represent a very small proportion of the number of helicopters involved in wildland fire suppression annually.

In July, 2008, a Sikorsky S-61 helicopter under contract to the Forest Service crashed in Northern California while transporting personnel who were fighting a wildfire, resulting in the deaths of seven firefighters, one pilot and one Forest Service Helicopter Inspector Pilot. While that tragedy is very fresh in the minds of the fire and aviation community, this independent risk assessment identifies hazards involved in transporting personnel on Type 1 helicopters and provides for mitigation measures for each hazard without focusing exclusively on the 2008 incident.

The USFS Systems Safety Aviation Guide, Tab 5, (Appendix B) is used as a point of departure for the independent risk assessment for personnel transportation in Type 1 helicopters. This assessment accepts the helicopter system-wide hazards, mitigations, costs and benefit comparisons. This assessment moves beyond them to address the specific hazards, mitigations, cost benefit comparisons and analysis that apply specifically to the mission of personnel transportation in Type 1 helicopters.

Study Plan

The focus of the independent risk assessment of personnel transportation in Type 1 helicopters was to identify and develop the hazard and mitigation measures, benefits and cost by the subject matter experts. Two workshops were conducted and facilitated by the consultants to accomplish this task.

The first workshop focused on the development of hazards and mitigation measures associated with the transportation of personnel in Type 1 helicopters. The second workshop consisted of finalizing mitigations, establishing the relative effectiveness of the mitigation measures and establishing benefits and costs for each mitigation measure.

The consultants developed a mathematical model to evaluate the effectiveness of the mitigation measures as well as benefits and costs. The initial parameters and definitions for the model were developed by the SMEs referenced by a guidance document provided by Baldwin Aviation, Inc**.** Baldwin Aviation reviewed the proposed model and indicated their belief that it would be effective.

The consultants then utilized the information provided by the SMEs to develop conclusions and observations to be communicated to the agency.

Background

A comprehensive history of the use of Type 1 helicopters in personnel transportation by the Forest Service could not be located. Anecdotal information indicates that firefighting personnel were transported in military Type 1 helicopters in the 1980's and most likely earlier. The use of Type 1 helicopters for water dropping, retardant dropping, internal cargo and external cargo transport occurred from 1971 and possibly earlier.

A CH-47 Chinook helicopter, which is the military equivalent of the civilian Boeing-Vertol (BV) 234 helicopter, was used to transport firefighting personnel during the Yellowstone fires of 1988. An Aerospatiale Puma or Super Puma helicopter was used to transport personnel on large wildfires in California in 1998.

In 2002, a contract for a Siskorsky S-61 in Southern California was awarded with the specific mission of being able to transport personnel. An initial attack helitack crew, whose skills included rappelling, was assigned to the helicopter. This program continued thru 2006.

The Forest Service significantly increased its contract fleet of Type 1 helicopters approved for personnel transport from one during the years 2002-2006, to seven in 2008. This increase occurred in response to the demand to transport an increased number of firefighters beyond the capability of

Type 2 helicopters.

A US Army Reserve CH-47 helicopter, which had been transporting firefighting personnel, was involved in an accident in 1994, on the Payette NF, which was fatal to a non-pilot crewperson. In 2008, an accident in Northern California involving an S-61 helicopter transporting personnel resulted in the deaths of seven firefighters, one pilot and one Forest Service Inspector Pilot.

In reviewing the increase in size of the program and in assessing early lessons learned from the 2008 Northern California accident, the National Director of Fire and Aviation Management initiated this independent risk assessment of personnel transport with Type 1 helicopters in January 2009. Type 1 helicopters transported 16,149 personnel from 2002-2008, with most of the personnel transported being the initial attack module assigned to the helicopter.

Assumptions

This independent risk assessment is focused upon the mission of the transportation of personnel by Type 1 helicopters in the wildfire environment. Other uses of Type 1 helicopters including water and retardant drops as well as rappelling from Type 1 helicopters were not addressed in this risk assessment.

This independent risk assessment considered but is not limited to the following issue areas:

- Environmental factors
- Terrain
- Special pilot skills
- Helicopter design and performance
- Ground support needs

The independent risk assessment considered ten years of data regarding the Forest Services' experience with the transport of personnel by Type 1 helicopters. Helicopter flight hour data for transportation of personnel by Type 1 helicopters was available for six of the past ten years. There were so few flight hours that little statistical value and analytical value could be deduced.

The 2008 System Safety Aviation Guide (Appendix B) was used as a point of departure from which this specific independent risk assessment was performed.

The independent risk assessment was done with a general awareness of the events regarding the 2008 Type 1 helicopter accident in Northern California but no information regarding the progress of the accident investigation nor were any specific accident details provided to the consultants or Baldwin Aviation personnel.

The subject matter experts projected that within the next ten years, there would be an annual demand for between three and ten Type 1 exclusive-use contract helicopters to transport personnel. The consultants assumed a "clean slate approach" and were not constrained by current methods, procedures or existing aviation contracts.

This independent risk assessment made no attempt to do a program review of any aspect of the Forest Service helicopter program. No attempt was made to determine the adequacy of staffing, in terms of numbers neither of positions filled nor in their performance. In the conclusions section, the consultants reiterate their recent findings regarding helicopter program issues including staffing. No attempt was made to determine the relative importance of the overall mission of transporting personnel in Type 1 helicopters to the wildland fire environment.

The independent risk assessment assumed that Type 1 helicopters certificated under Civil Aviation Regulation (CAR) part 7 (e.g. S 61), and those more recently certificated under Federal Aviation Regulations 27 and 29 could be used to transport personnel.

The independent risk assessment assumed that all contractors bidding on exclusive use contracts would possess Federal Aviation Administration (FAA) certificates under FAR Parts 133, 135 and 137.

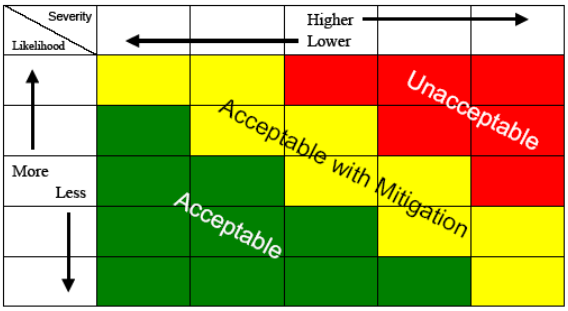
Hazards and Mitigation Measures

The agreement between the Forest Service (FS) and the consultants did not specify the methodology to be used to accomplish the independent risk assessment. The consultants, with the assistance of Baldwin Aviation, designed a risk assessment process based upon the principles of Safety Management Systems (SMS) as described in FAA Circular 120-92 (Appendix J).

The Circular states that:

"(5) Risk Acceptance. In the development of its independent risk assessment criteria, aviation service providers are expected to develop risk acceptance procedures, including acceptance criteria and designation of authority and responsibility for risk management decision-making. The acceptability of risk can be evaluated using a risk matrix such as the one illustrated in Figure 1. The example matrix shows three areas of acceptability. Risk matrices may be color coded; unacceptable (red), acceptable (green), and acceptable with mitigation (yellow).

Figure 1 – From FAA Circular 120-92, Page 15.



(a) Unacceptable (Red). Where combinations of severity and likelihood cause risk to fall into the red area, the risk would be assessed as unacceptable and further work would be required to design an

intervention to eliminate that associated hazard or to control the factors that lead to higher risk likelihood or severity.

(b) Acceptable (Green). Where the assessed risk falls into the green area, it may be accepted risk to as low as practicable regardless of whether or not the assessment shows that it can be accepted as is. This is a fundamental principle of continuous improvement.

(c) Acceptable with mitigation (Yellow). Where the independent risk assessment falls into the yellow area, the risk may be accepted under the defined conditions of mitigation."

The Forest Service, in developing the 2008 Systems Safety Aviation Guide, did not establish risk thresholds including risk acceptance and management processes as described in Section 5 (a), (b) and (c) of the FAA Circular 120-92. The process used to develop the hazards and mitigation measures together with the ratings of each pre-mitigation and post-mitigation compared the likelihood and severity rating to obtain an outcome of Low, Medium, Serious or High (see Figure 2). The process did not establish within these four outcome values which values were unacceptable, acceptable with mitigation or acceptable without mitigation.

Figure 2 – Outcome Matrix from Forest Service 2008 Systems Safety Aviation Guide *

			Severity					
			Negligible	Marginal	Critical	Catastrophic		
			1	2	3	4	Outcome	
Likelihood	Improbable	1	2	3	4	5	High	
	Remote	2	3	4	5	6	Serious	
	Occasional	3	4	5	6	7	Medium	
	Frequent	4	5	6	7	8	Low	
	Probable	5	6	7	8	9		

* - The 2008 Systems Safety Aviation Guide did not display an Outcome matrix but the consultants were able to develop this matrix based on the outcome values.

In this project, the consultants utilized a similar process as used by the Forest Service in preparing the 2008 Systems Safety Aviation Guide, but with modifications. The key modification was the development of an additional rating matrix for the cost~benefit of the mitigation measures.

As used by the Forest Service in the 2008 Systems Safety Aviation Guide, all hazards appear to be classified as Section 5 (c), FAA Circular 120-92, acceptable with mitigation. In this independent risk assessment the consultants followed the same procedure. The consultants assume the Forest Service might utilize an additional process such as a program review to determine which hazards fall within the categories of Section 5 (a), (b) and (c) from FAA Circular 120-92.

The rankings are made in relationship to each other and do not propose benchmarks such as acceptable, unacceptable or acceptable with mitigation. The consultants believe that establishing these benchmarks is a task that the FS will need to accomplish to further implement the Safety Management System.

Identification of Systems and Subsystems

Using Tab 5 of the 2008 Forest Service System Safety Aviation Guide as a reference, the SME's identified four systems. They further identified 11 subsystems some of which appear in more than one system.

Aircraft System

- Configuration Subsystem
- Visibility Subsystem
- Communication Subsystem
- Policy Subsystem

Personnel Government System

- Configuration Subsystem
- Training Subsystem
- Environment Subsystem
- Mission Subsystem
- Management Subsystem
- Inspection Subsystem
- Crew Resource Management Subsystem

Personnel Contractor System

- Configuration Subsystem
- Mission Subsystem
- Capability Subsystem

Operations System

- Management Subsystem

Hazards and mitigation measures were defined within each of the categories. A listing of these is shown in Appendix C.

Evaluation of Hazards and Mitigation Measures

The identification of hazards and mitigation measures for transporting personnel in Type 1 helicopters was developed using a process similar to the one described in the 2008 Systems Safety Aviation Guide, Tab 5, System Safety Assessment – Helicopters.

Hazards and mitigation measures specific to the mission were identified in a workshop with three of the SMEs: the National Helicopter Program Manager, National Helicopter Operations Specialist and the National Aviation Training Specialist. At times, the Airworthiness and Logistics Officer was consulted by telephone.

Following the initial identification of hazards and mitigation measures, the list was distributed to all SMEs for comment and critique. Data and information was also gathered by SMEs in support of the development of evaluation and rating of each hazard and mitigation measure.

Evaluation Model Description

The consultants facilitated a second workshop. This workshop was attended by the National Helicopter Program Manager, the National Helicopter Operations Specialist, the National Aviation Training Specialist and the Pacific Northwest Region's Aviation Operations Manager. The consultants facilitated a process where the SMEs developed an evaluation and rating matrix. One item classified was the probability (likelihood) or in some cases the significance of a hazard. Some hazards could be classified based on their probability of occurrence but most were classified on their significance. The second item classified was the severity (consequences) of a hazard. Each was classified pre-mitigation and post-mitigation.

Figure 3 – Rating Matrix for Rating Hazards Pre-Mitigation and Post-Mitigation

						Severity				
						No effect no damage	No lost time injury Minor dings	Loss time injury Damage ≤ 3 days	Serious injury Replace Aircraft	Death Total the Aircraft
						Extremely Low	Low	Moderate	High	Extreme
		Probability	Signifcance			1	3	9	12	15
Probability or Significance	5 yr+	Extremely Low	Very Low		1	2	4	10	13	16
	1 yr	Low	Less		2	3	5	11	14	17
	3 mo	Moderate	Moderate		3	4	6	12	15	18
	1 wk	High	Very		4	5	7	13	16	19
	daily	Extreme	Most		5	6	8	14	17	20

Rating
Extreme
High
Serious
Medium
Low

The classifications and the resultant rating matrix is shown in Figure 3. The SME assigned a numeric value to each classification. The sum of these two numbers became the score for each combination of probability/significance and severity. The SMEs structured the scores into five rating classes are shown in Figure 4.

Figure 4 – Scores Defining the Ratings

Score	Rating
15-20	Extreme
12-14	High
7-11	Serious
5-6	Medium
2-4	Low

Next, the SMEs were asked to develop estimates for the costs to implement each mitigation measure. Some measures can be implemented with minimal to no cost and some measures might require millions of dollars. The SMEs were also asked to assign a benefit classification to each mitigation measure. The classifications and the resultant rating matrix is shown in Figure 5.

Figure 5 – Rating Matrix for Costs and Benefits Pre-Mitigation and Post-Mitigation

					Benefit			
					Minor Improvement	**Moderate Improvement**	**Significant Improvement**	**Substancial Improvement**
					Low	Moderate	High	Very High
					1	3	6	8
Cost	**$1M+**	Very High		1	2	4	7	9
	$100K-$1M	High		2	3	5	8	10
	$10-100K	Moderate		3	4	6	9	11
	0-$10K	Low		4	5	7	10	12

Rating	
Very High	
High	
Medium	
Low	

The SME assigned a numeric value to each classification. The sum of these two numbers became the score for each combination of cost and benefit. The SMEs structured the scores in four rating classes as shown in Figure 6.

Figure 6 – Scores Defining the Ratings

Score	Rating	
10-12	Very High	
7-9	High	
4-6	Medium	
2-3	Low	

Rating of Hazards and Mitigation Measures With Benefits and Costs

A listing of the hazards and mitigation measures follow, including ratings for pre-mitigation, post-mitigation and benefit~cost.

Table 1 - Type 1 Helicopter Use for Personnel Transport

Aircraft System														
			Pre-mitigation					Post-mitigation			Benefit-Cost		
Sub-System	ID	Hazards	Prob	Severity	Rating	ID	Mitigation	Prob	Severity	Rating	Cost	Benefit	Rating
Configuration	A1	Due to the size of the interior and door location, it is more difficult to escape in case of accident or incident.	Moderate	High	Extreme	A1M1	Develop and implement rapid escape procedures.	Low	High	High	High	High	High
	A2	Ingress and Egress into aircraft is complicated. The management and logistics are more complex dealing with more people and a non-standard seating arrangement.	Moderate	Moderate	High	A2M1	Identify and implement a standardized interior configuration including seat numbers and seat general location by aircraft model and type.	Low	Moderate	Serious	Low	High	Very High
						A2M2	Ingress and egress should be facilitated by railings, handholds, stairs with defined step height, etc. For each aircraft type, a cabin safety analysis will be done to define the measures and actions needed for personnel to ingress and egress the helicopter. Require an Original Equipment Manufacturer (OEM) passenger loading measures like air-stairs or a ramp on all Type 1 personnel transport helicopters.	Low	Moderate	Serious	High	High	High
						A2M3	Address personnel transportation ingress and egress for Type 1 helicopters in the following training: Helicopter Crew Person, Helicopter Manager, Helibase Manager, Air Support, Air Operations, S-270 (Basic Air Operations), etc.	Low	Moderate	Serious	Mod	High	High
	A3	Seat restraints, seats and seat attachments for the aircraft are non-standard in their configuration and meets different minimal legacy Federal Aviation Administration (FAA) standards.	High	Extreme	Extreme	A3M1	The agency should require all personnel seats are substantiated to PART 29 requirements.	Low	Moderate	Serious	High	Very High	Very High
	A4	Non-standardized storage of interior cargo including provisions for approved storage methods of boxes, nets and restraints.	High	High	Extreme	A4M1	The agency should utilize FAA standards for a restraint system. The agency should develop location schematic and size standards by aircraft by model and type.	Low	Low	Serious	Low	High	Very High
Visibility	A5	Limited visibility exists from inside of the cabin, which restricts the ability of the helicopter manager to assist in identifying external hazards.	Moderate	Moderate	High	A5M1	Utilize at least one observer bubble window on each side of the aircraft closest to exit doors with intercommunication system access capabilities.	Low	Low	Serious	Mod	Moderate	Medium
						A5M2	Wire strike kits will be required if available.	Low	Low	Serious	Mod	Moderate	Medium
Communications	A6	Notification of personnel during emergency who do not have helmets with audio for contact.	High	High	Extreme	A6M1	The agency should utilize a personnel notification system such as a public address system, horn or siren to alert passengers of emergency. Activation of the personnel notification system should be possible by the helicopter manager as well as the flight crew.	Low	Moderate	Serious	Low	Moderate	High
Policy	A7	The loss of 19 passengers from an accident on a single flight in a Type 1 helicopter is perceived to be a greater hazard than the loss of a lesser number of passengers in a Type 2 or a Type 3 helicopter.	High	High	Extreme	A7M1	Apply appropriate standards regardless of the type and certification standards of the helicopter. The number of passengers will be determined by the performance of the aircraft.	Moderate	Moderate	High	Low	High	Very High

Table 2 - Type 1 Helicopter Use for Personnel Transport

Personnel Government System

			Pre-mitigation					Post-mitigation			Benefit*Cost		
Sub-System	ID	Hazards	Prob	Severity	Rating	ID	Mitigation	Prob	Severity	Rating	Cost	Benefit	Rating
Configration	PG1	The ingress and egress into aircraft is more complicated due to the multiple different configurations of doors and stairs.	High	Moderate	High	PG1M1	The agency should require an Original Equipment Manufacturer (OEM) passenger loading measures like air-stairs or a ramp on all Type 1 personnel transport helicopters. Identify a standardized door configuration by make and model.	Low	Low	Medium	Low	High	Very High
						PG1M2	The helicopter manager will review the mission requirements and brief the pilot(s) on the mission profile and planning.	Low	Moderate	Serious	Low	Moderate	High
Training	PG2	Aircraft Maintenance Inspectors (AMI) are less familiar personnel transport cabin configuration requirements for a Type 1 helicopter than other types of helicopters.	High	High	Extreme	PG2M1	The agency should accelerate training and mentoring of aircraft maintenance inspectors.	Low	Moderate	Serious	High	Very High	Very High
	PG3	There is a lack of standardization between helicopter inspector pilots (HIP) regarding pilot evaluation.	High	High	Extreme	PG3M1	The agency should implement a standardized procedure pertaining to evaluation of contractor helicopter pilots.	Low	Moderate	Serious	Low	Very High	Very High
	PG4	The load calculation process is more complex for some Type 1 helicopters used in personnel transport.	High	Extreme	Extreme	PG4M1	Develop an electronic load calculation and incorporate its use in Helicopter Manager and Crewperson training.	Low	Moderate	Serious	High	Very High	Very High
						PG4M2	Place the electronic load calculation process on the Interagency Aviation Training web site.	Low	Moderate	Serious	Low	Very High	Very High
Environment	PG5	A Type 1 helicopter has a larger footprint requiring a larger helispot. A longer and wider departure and arrival path is required.	Moderate	Moderate	High	PG5M1	Insure there is an adequate approach and departure standard. Adhere to the Interagency Helicopter Operations Guide (IHOG) standards.	Low	Moderate	Serious	Low	Moderate	High
	PG6	A Type 1 helicopter has a greater rotor wash than Type 2 or 3 helicopters.	Moderate	Moderate	High	PG6M1	The agency should insure adequate dust abatement. The agency should insure ground personnel are outside of an adequate safety circle.	Low	Moderate	Serious	Low	Moderate	High
Mission	PG7	There is an element of complexity resulting from mission switch between water or retardant delivery to personnel delivery.	High	High	Extreme	PG7M1	The helicopter manager shall examine and brief the pilot(s) on the mission profile and planning. The HIP shall emphasize the issues related to mission change, particularly from external load to personnel transport. Utilize the electronic load calculation process for each mission.	Low	Moderate	Serious	Low	High	Very High

Table 2 - Type 1 Helicopter Use for Personnel Transport

Personnel Government System

			Pre-mitigation					Post-mitigation			Benefit*Cost		
Sub-System	ID	Hazards	Prob	Severity	Rating	ID	Mitigation	Prob	Severity	Rating	Cost	Benefit	Rating
Management	PG8	Incident Management Teams (IMTs) may not be fully aware of how to plan for and utilize Type 1 personnel transport in Operations. Some IMT including NIMO teams do not staff air operations positions. There is an overall shortage AOBD, ASGS, ATGS, HLCO and helibase managers (HEBM). There is a lack of general knowledge including risk assessment and hazard mitigation by the IMT.	High	High	Extreme	PG8M1	Adjust and develop USFS Pacific Southwest Region S-370 course, Intermediate Air Operations in a nationally adopted course. Suggested attendance is Crew Boss (CRWB) and higher including currently qualified personnel.	Low	High	High	Mod	High	High
						PG8M2	The agency should increase it capacity in aviation management positions by staffing three Type 1 exclusive-use helicopters to train staff in advanced aviation management skills.	Low	Moderate	Serious	Very High	High	High
						PG8M3	Require aviation management staffing on Incident Management Teams including NIMO teams. Staffing should be appropriate for the complexity of incident.	Low	High	High	High	High	High
	PG9	There is an agency need for an adequate number of Aircraft Maintenance Inspectors (AMI) that have specialized training and experience with the Type 1 helicopters.	High	High	Extreme	PG9M1	The agency should implement the optimal number of AMI positions and skills needed based on workload defined by the program of work.	Low	Moderate	Serious	High	Very High	Very High
	PG10	There is an agency need for adequate number of Helicopter Pilot Inspectors (HIP) that have specialized training and experience with the Type 1 helicopters.	High	Extreme	Extreme	PG10M1	The agency should identify and implement the number of HIPs and skills needed based on workload defined by the program of work.	Low	Moderate	Serious	High	Very High	Very High
Inspection	PG11	There is a need to establish a practical test standard for a Type 1 pilot check ride for passenger transport.	High	Extreme	Extreme	PG11M1	The agency should determine and implement a change to the interagency practical test standards for pilots of Type 1 helicopters performing personnel transport missions. Establish a standardized Safety Briefing/Oral Evaluation for pilots transporting personnel in Type 1 helicopters.	Low	Moderate	Serious	Low	High	Very High
Crew Resource Management	PG12	There is a limited ability for Crew Resource Management (CRM) to occur due to the placement of interior walls in all Type 1 helicopters.	Moderate	Moderate	High	PG12M1	The agency should establish the capability to permit mobility of helicopter managers while in flight in Type 1 helicopters leading to improved crew resource management.	Low	Moderate	Serious	Mod	Moderate	High
						PG12M2	Exclusive-use Helicopter Managers will be required to attend Crew Resource Management (CRM) training (16-hour version).	Low	Low	Medium	High	Moderate	Medium

Table 3 - Type 1 Helicopter Use for Personnel Transport

Personnel Contractor

			Pre-mitigation					Post-mitigation			Benefit~Cost		
Sub-System	ID	Hazards	Prob	Severity	Rating	ID	Mitigation	Prob	Severity	Rating	Cost	Benefit	Rating
Configuration	PC1	Establishing and documenting the center of gravity and weight and balance calculations are critical steps to support mission planning and implementation.	High	High	Extreme	PC1M1	The vendor will provide the center of gravity and weight and balance limitations for internal cargo maximum weight. All multi-engine aircraft shall perform a weight and balance calculation prior to every takeoff when transporting personnel.	Low	Low	Medium	Low	High	Very High
Mission	PC2	Transporting passengers is can be an infrequent mission for most Type 1 helicopter pilots. In general, pilots are not familiar with changing types during a day. Personnel transport requires a different flying technique than other Type 1 helicopter missions.	High	Extreme	Extreme	PC2M1	The agency should work with other agencies to determine and implement a change to the interagency practical test standards for Type 1 personnel transport helicopters.	Low	Moderate	Serious	Low	Very High	Very High
Crew Resource Management	PC3	Crew Resource Management (CRM) is different in a Type 1 due to limited visibility and limited site access to pilots.	High	Moderate	High	PC3M1	PIC and SIC will be required to attend the agency crew resource management (CRM) or equivalent training (16 hour version) every contract cycle.	Low	Moderate	Serious	Mod	High	High
Capability	PC4	Contractors used for Type 1 personnel transport in the wildland fire environment may not have extensive experience in the personnel transport mission.	High	Extreme	Extreme	PC4M1	The agency should complete an independent Aviation Audit of Type 1 operators that perform personnel transport to determine the depth and quality of the operators' background and experience in performing this mission.	Low	Moderate	Serious	Mod	High	High

Table 4 - Type 1 Helicopter Use for Personnel Transport

Operations System

			Pre-mitigation					Post-mitigation			Benefit~Cost		
Sub-System	ID	Hazards	Prob	Severity	Rating	ID	Mitigation	Prob	Severity	Rating	Cost	Benefit	Rating
Management	O1	Incident Management Teams (IMTs) may not be fully aware of how to plan for and utilize Type 1 personnel transport in Operations. Some IMT including NIMO teams do not staff air operations positions. There is an overall shortage AOBD, ASGS, ATGS, HLCO and helibase managers (HEBM). There is a lack of general knowledge including risk assessment and hazard mitigation by the IMT.	High	High	Extreme	O1M1	Adjust and develop USFS Pacific Southwest Region S-370 course, Intermediate Air Operations in a nationally adopted course. Suggested attendance is Crew Boss (CRWB) and higher including currently qualified personnel.	Low	High	High	High	High	High
	O2	The agency lacks a process to evaluate helicopters used in personnel transport missions. Budget constraints limit the ability of the agency to select optimal aircraft and appropriate support staff for the passenger transport mission.	High	High	Extreme	O2M1	The agency should establish and implement an evaluation process for platforms for Type 1 personnel transport platforms.	Low	Low	Medium	High	Very High	Very High
						O2M2	Establish and implement required program support personnel positions.	Low	Low	Medium	Mod	Very High	Very High
						O2M3	Establish and request an adequate budget to implement the requested program.	Low	Low	Medium	Very High	Very High	High

Considerations for Implementing Mitigation Measures

In Tables A – D, each mitigation measure is listed with residual risk, substitute risk and implementation considerations. Residual risk is defined as the risk remaining after mitigation is implemented. Substitute risk is defined as any hazard that is introduced by a mitigation effort. Implementation considerations include a discussion of the following:

- Ease of introduction; i.e. Will this measure be difficult to introduce?
- Acceptance; i.e. Will users and management accept this measure?
- Durability; i.e. Will this measure stand the test of time?
- Enforceability; i.e. Will the measure be implemented?
- Expanded effect; i.e. Could implementation of this measure change standards for other contract helicopters?
- Time to implement from time of adoption; i.e. It could be an immediate implementation (one month or less), short-term (one to six months), long-term period (6 months to one year) or extended period (greater than one year).

Effectiveness of the mitigation measure is addressed in the comparison of pre-mitigation and post-mitigation ratings.

Table 1 – Analysis of Mitigation Measures – The Aircraft System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
A1M1	Develop and implement rapid escape procedures	The post mitigation outcome is reduced one level from extreme to high. The inherent design of many Type 1 helicopters prevents the hazard from being lowered further.	None anticipated.	None anticipated. Less than 30 days to implement.
A2M1	Identify and implement a standardized interior configuration including seat numbers and seat general location by aircraft model and type.	The post mitigation outcome is reduced one level from high to serious. The inherent design of many T1 helicopters prevents the hazard from being further lowered.	None anticipated.	This may change the payload of the aircraft. One year or less to implement.

Table 1 – Analysis of Mitigation Measures – The Aircraft System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
A2M2	Ingress and egress should be facilitated by railings, handholds, stairs with defined step height, etc. For each aircraft type, a cabin safety analysis will be done to define the measures and actions needed for personnel to ingress and egress the helicopter. Require an Original Equipment Manufacturer (OEM) passenger loading measures like air-stairs or a ramp on all Type 1 personnel transport helicopters.	The post mitigation outcome is reduced one level from high to serious. The inherent design of many T1 helicopters prevents the hazard from being further lowered.	None anticipated.	Adoption within a contract period may require funding. One year or less to implement.
A3M1	The agency should require all personnel seats are substantiated to PART 29 requirements.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	Adoption within a contract period may require funding. Greater than one year to implement. This standard would result in a review of standards for many Type 2 and Type 3 helicopters.
A4M1	The agency should utilize FAA standards for a restraint system. The agency should develop a location schematic and size standards by model and type.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	Adoption within a contract period may require funding. Greater than one year to implement.
A5M1	Utilize at least one observer bubble window on each side of the aircraft closest to exit doors with intercommunication system access capabilities.	None	None anticipated.	Adoption within a contract period may require funding. Less than one month to implement.

Table 1 – Analysis of Mitigation Measures – The Aircraft System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
A5M2	Wire strike kits will be required if available.	The post mitigation outcome is reduced one level from high to serious.	None anticipated.	Unlikely that kits will be developed for many if not all of the T1 helicopters.
A6M1	The agency should utilize a personnel notification system such as a public address system, horn or siren to alert personnel of emergency. Activation of the personnel notification system should be possible by the helicopter manager as well as the flight crew.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	Adoption within a contract period may require funding. Less than one month to implement.
A7M1	Apply appropriate standards regardless of the type and certification standards of the helicopter. The number of personnel will be determined by the performance of the aircraft.	The post mitigation outcome is reduced one level from extreme to high.	None anticipated.	This will require extensive analysis and coordination to develop and multiple years to develop. This measure affects the standards for all Type 2 and Types 3 helicopters. Greater than one year to implement.

Table 2 – Analysis of Mitigation Measures – The Personnel Government System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
PG1M1	The agency should require an Original Equipment Manufacturer (OEM) passenger loading measures like air-stairs or a ramp on all Type 1 personnel transport helicopters. Identify a standardized door configuration by make and model.	The post mitigation outcome is reduced two levels from high to medium.	None anticipated.	The same as A2M2. Adoption within a contract period may require funding. One year or less to implement
PG1M2	The helicopter manager will review the mission requirements and brief the pilot(s) on the mission profile and planning.	The post mitigation outcome is reduced one level from a high to a serious.	None anticipated.	One month or less to implement.
PG2M1	The agency should accelerate training and mentoring of aircraft maintenance inspectors.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	Greater than one year to implement.
PG3M1	The agency should implement a standardized procedure pertaining to evaluation of contractor helicopter pilots.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	One month or less to implement.
PG4M1	Develop an electronic load calculation and incorporate its use in Helicopter Manager and Crewperson training.	The post mitigation outcome is reduced two levels from extreme to serious.	Reliance on an electronic system could cause manual skills to atrophy.	Six months to one year to implement.
PG4M2	Place the electronic load calculation process on the Interagency Aviation Training web site.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	Six months to one year to implement.

Table 2 – Analysis of Mitigation Measures – The Personnel Government System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
PG5M1	Insure there is an adequate approach and departure standard. Adhere to the Interagency Helicopter Operations Guide (IHOG) standards.	None anticipated.	None anticipated.	Extensive education of agency administrators will be required to achieve acceptance of larger helispots. Greater than one year to implement.
PG6M1	The agency should insure adequate dust abatement. The agency should insure ground personnel are outside of an adequate safety circle.	The post mitigation outcome is reduced one level from high to serious.	None anticipated.	One month or less to implement.
PG7M1	The helicopter manager shall examine and brief the pilot(s) on the mission profile and planning. The HIP shall emphasize the issues related to mission change, particularly from external load to personnel transport. Utilize the electronic load calculation process for each mission.	The post mitigation outcome is reduced two levels from high to serious.	None anticipated.	One month or less to implement.
PG8M1	Adjust and develop USFS Pacific Southwest Region S-370 course, Intermediate Air Operations in a nationally adopted course. Suggested attendance is Crew Boss (CRWB) and higher including currently qualified personnel.	The post mitigation outcome is reduced one level from extreme to high.	None anticipated.	This mitigation will require more than one year and will require a well-developed strategy and personal advocacy by leaders to successfully implement. This measure affects all helicopter operations.

Table 2 – Analysis of Mitigation Measures – The Personnel Government System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
PG8M2	The agency should increase it capacity in aviation management positions by staffing three Type 1 exclusive-use helicopters to train staff in advanced aviation management skills.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	This mitigation will require more than one year and will require a well-developed strategy and personal advocacy by leaders to successfully implement.
PG8M3	Require aviation management staffing on Incident Management Teams including NIMO teams. Staffing should be appropriate for the complexity of incident.	The post mitigation outcome is reduced one level from extreme to high.	None anticipated.	This mitigation will require more than one year and will require a well-developed strategy and personal advocacy by leaders to successfully implement.
PG9M1	The agency should implement the optimal number of AMI positions and skills needed based on workload defined by the program of work.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	This mitigation will require more than one year to implement.
PG10M1	The agency should identify and implement the number of HIPs and skills needed based on workload defined by the program of work.	The post mitigation outcome is reduced by two levels from extreme to serious.	None anticipated.	This mitigation will require more than one year to implement that will require a significant investment in personnel development.

Table 2 – Analysis of Mitigation Measures – The Personnel Government System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
PG11M1	The agency should determine and implement a change to the interagency practical test standards for pilots of Type 1 helicopters performing personnel transport missions. Establish a standardized Safety Briefing/Oral Evaluation for pilots transporting personnel in Type 1 helicopters.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	Less than one month to implement.
PG12M1	The agency should establish the capability to permit mobility of helicopter managers while in flight in Type 1 helicopters leading to improved crew resource management.	The post mitigation outcome is reduced one level from high to serious.	None anticipated.	Development of the system may take six months to one year to implement Adoption within a contract period may require funding.
PG12M2	Exclusive-use Helicopter Managers will be required to attend Crew Resource Management (CRM) training (16-hour version).	The post mitigation outcome is reduced two levels from high to moderate.	None anticipated.	This mitigation will require more than one year and will require a well-developed strategy and personal advocacy by leaders to successfully implement. This measure affects helicopter managers for all Type 2 and Type 3 helicopters.

Table 3 – Analysis of Mitigation Measures – The Personnel Contractor System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
PC1M1	The vendor will provide the center of gravity and weight and balance limitations for internal cargo maximum weight. All multi-engine aircraft shall perform a weight and balance calculation prior to every takeoff when transporting personnel.	The post mitigation outcome is reduced three levels from extreme to medium.	None anticipated.	None anticipated.
PC2M1	The agency should work with other agencies to determine and implement a change to the interagency practical test standards for Type 1 personnel transport helicopters.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	The same as PG11M1. Less than one month to implement.
PC3M1	The Pilot in Command (PIC) and Second in Command (SIC) will be required to attend Crew Resource Management (CRM) or equivalent training (16-hour version) every contract cycle.	The post mitigation outcome is reduced one level from high to serious.	None anticipated.	Adoption within a contract period may require funding. This measure affects helicopter pilots for all Type 2 and Type 3 helicopters.
PC4M1	The agency should complete an independent aviation audit of Type 1 operators that perform personnel transport to determine the depth and quality of the operators' background and experience in performing this mission.	The post mitigation outcome is reduced two levels from extreme to serious.	None anticipated.	None anticipated.

Table 4 – Analysis of Mitigation Measures – The Operations System

Mitigation Measure ID	Mitigation Measure	Residual Risk	Substitute Risk	Implementation Considerations
O1M1	Adjust and develop USFS Pacific Southwest Region S-370 course, Intermediate Air Operations in a nationally adopted course. Suggested attendance is Crew Boss (CRWB) and higher including currently qualified personnel.	The post mitigation outcome is reduced one level from extreme to high.	None anticipated.	The same as PG8M1. This mitigation will require more than one year and will require a well-developed strategy and personal advocacy by leaders to successfully implement. This measure affects all helicopter operations.
O2M1	The agency should establish and implement an evaluation process for platforms for Type 1 personnel transport platforms.	The post mitigation outcome is reduced three levels from extreme to medium.	None anticipated.	This measure affects all Type 2 and Type 3 helicopters.
O2M2	Establish and implement required program support personnel positions.	The post mitigation outcome is reduced three levels from extreme to medium.	None anticipated.	None anticipated.
O2O3	Establish and request an adequate budget to implement the requested program.	The post mitigation outcome is reduced three levels from extreme to medium.	None anticipated.	None anticipated.

Conclusions

The consultants believe that personnel transport in Type 1 helicopters can be done with improved reliability and safety, but only with the successful implementation of mitigation measures that address the specific hazards posed by this mission. The conclusions stated below incorporate observations that the consultants documented in other recent consulting work with the Forest Service. The consultants suggest that Forest Service decision-makers, in assessing the appropriateness and effectiveness of mitigation measures, consider these conclusions.

Conclusion 1

Benchmarking the outcomes of this independent risk analysis against Forest Service expectations for program performance isn't attempted, as the Forest Service hasn't established risk acceptance standards and procedures for its aviation operations. Forest Service leaders need to determine the level of acceptable residual risk.

Discussion of Conclusion 1

Consideration needs to be given by the Forest Service to FAA Circular 120-92, which says in part, "In the development of its independent risk assessment criteria, aviation service providers are expected to develop risk acceptance procedures, including acceptance criteria and designation of authority and responsibility for risk management decision making." (Appendix J, page 14).

Conclusion 2

Transporting personnel in Type 1 helicopters is a mission, which has significant similarities to transport of personnel in Type 2 and 3 helicopters. However, there are some highly significant and important differences.

Discussion of Conclusion 2

Many times, the SMEs stated that a Type 1 helicopter is "not just a big Type 2." What they meant is that the aircraft configuration results in longer ingress and egress times. Also the aircraft size, configuration and rotor size and wash require a larger helispot and additional dust abatement. Some of the contractors utilized for personnel transport may have had relatively little actual experience in this specific mission. Incident Management Teams and personnel in the aviation management positions have not been provided with specific training for the planning for or implementation of this mission.

Conclusion 3

The SMEs were able to develop one or more mitigation measures for each identified hazard. Each mitigation measure reduced the outcome rating by at least one level. Some mitigation measures have a higher overall benefit versus cost than others.

Discussion of Conclusion 3

Four mitigation measures (11%) reduced the outcome rating by three rating levels, 16 mitigation measures (46%) reduced the outcome rating by two rating levels and 15 mitigation measures (43%) reduced the outcome rating by one rating level. It is up to the Forest Service to decide whether to implement one or all of the mitigation measures. In the view of the SMEs, all of the mitigation measures need to be implemented though the timeframe needed for implementation will vary by mitigation measure.

Conclusion 4

Many of the mitigation measures that were developed were in response to hazards that often exist during personnel transport using Type 2 or 3 helicopters as well as in Type 1 helicopters.

Discussion of Conclusion 4

In these cases, there can be a expanding effect resulting from accepting a hazard and mitigation for personnel transport using to Type 1 helicopters as the same hazard and mitigation measures might also apply to personnel transport using Type 2 or Type 3 helicopters.

Conclusion 5

The mitigation measures will either reduce the likelihood of a mishap or lessen the potential consequence of a mishap.

Discussion of Conclusion 5

Some of the mitigation measures are short-term opportunities and others will require multiyear strategies to address and resolve. This determination needs to consider implementation considerations, implementation feasibility, the costs and benefits of the mitigation measures and the overall priority given to the mission of transportation of personnel with Type 1 helicopters.

Conclusion 6

Many Forest Service positions are essential for the successful implementation of Type 1 helicopters for personnel transport missions and are vacant or are in critically short supply. These vacancies also exist in the support of other helicopter missions as well.

Discussion of Conclusion 6

These positions include Helicopter Inspector Pilots (HIPs), Aviation Maintenance Inspectors (AMI's), Regional Aviation Safety and Training Managers (RASTMs) and a National Helicopter Pilot Standardization Specialist. Positions with chronic shortages include incident management aviation positions such as Air Operations Branch Director, Air Tactical Group Supervisor, Air Support Group Supervisor and Helibase Manager.

Conclusion 7

The mission of personnel transport in Type 1 helicopters grew from one to seven helicopters in recent years without a Program Review coupled with a Safety Management Systems analysis to identify the hazards and mitigation measures presented by this new mission and volume of business. This new mission involved significant changes for the contractors, some of whom had minimal experience transporting personnel, and for the Forest Service, which also had little experience performing this mission.

Discussion of Conclusion 7

Safety Management Systems analysis is a powerful tool, which can greatly assist aviation managers in program design, particularly when coupled with a Program Review.

Conclusion 8

The significant increase in the number of exclusive use contract Type 1 and 2 helicopters and shift in their management to the national aviation operations office has greatly impacted the National Helicopter Program Manager and National Helicopter Operations Specialist positions.

Discussion of Conclusion 8

The time spent by the National Helicopter Program Manager and National Helicopter Operations Specialist has shifted from a focus on national and interagency policy and coordination to mainly program managers of the exclusive use contract Type 1 and 2 programs. This results in limited time for national and interagency policy and coordination, which provides the overall program oversight.

Observations

While completing this independent risk assessment, the consultants documented the following observations. These do not directly affect the risk assessment but Forest Service aviation leaders should consider them.

1. Strategic Planning Team: Input from the SMEs indicated the need for an aviation strategic planning team that would harmonize contract requirements and helicopter capabilities while integrating SMS concepts. This team would be needed for a 3-5 year period.

2. Priorities and Program Reviews: Input from the SMEs and others indicate that Aviation Management Reviews and Site Visits (FSM 5719.1) have not occurred in recent years due to reprioritizing of program managers' time just to accomplish contracting, inspections and training.

3. Safety Influences: Input from the SMEs indicates that Agency Administrators often give direction to avoid creating ridgetop "gunsight" clearways associated with helispots. This often leads to extensive discussions regarding the size and shape of the clearway and the helispot.

4. Clarity of Standards: The SMEs are unclear on the effect of blending FAR regulations with the status as a Public Aircraft Operation. They believe the situation should be reviewed and clarified.

5. SMS: There is some concern by the SMEs that the 2008 System Safety Guide, while a very good and necessary start, was prepared by a SME group that did not fully represent program-wide specialists.

6. Contract Oversight and Quality Assurance: John Nelson has developed an excellent concept, which outlines a holistic and unique approach to contract oversight and quality assurance, which should be considered by aviation program leaders.

Glossary

Air Operations Branch Director (AOBD) - This Incident Command System (ICS) position is responsible for management of an incident's air operations and reports to the Operations Section Chief.

Air Support Group Supervisor (ASGS) - This ICS position is responsible for overseeing logistical support and management of helibase and helispot operations and temporary fixed-wing base(s) and reports to the Air Operations Branch Director. This position also maintains liaison with air tanker and fixed-wing bases supporting incident operations.

Air Tactical Group Supervisor (ATGS) - This ICS position is responsible for directing and coordinating airborne aircraft operations and management of an incident's airspace and reports to the Air Operations Branch Director.

Aviation Maintenance Inspector – Aircraft Maintenance Inspectors (AMI) apply knowledge and skills regarding aircraft, aircraft parts, or avionics to administer regulations and safety standards pertaining to the airworthiness and maintenance of aircraft and related equipment in inspecting and approving vendor aircraft for use on Federal contracts.

Civil Aviation Regulation 7 – CAR 7 – Rotorcraft airworthiness, transport category, effective August 1, 1956. Establishes airworthiness standards for helicopters designed in the 1950's, 1960's and 1970's.

Crew Boss (CRWB) - A person in supervisory charge of usually 16 to 21 firefighters and is responsible for their performance, safety, and. welfare.

Division/Group Supervisor (DIVS) - The ICS position responsible for supervising equipment and personnel assigned to a division or group and reports to a Branch Director or Operations Section Chief.

Federal Aviation Regulation 135 - Part 135— Operating requirements: Commuter and on demand operations and rules governing persons on board such aircraft.

Federal Aviation Administration – The US Government agency whose mission is to provide a safe and efficient aerospace system.

Helibase Manager (HEB1 or HEB2) - This ICS position is responsible for controlling helicopter take-offs and landings at a helibase, managing helibase assigned helicopters, supplies, fire retardant mixing and loading and reports to the Air Support Group Supervisor.

Helicopter Coordinator (HLCO) - This ICS position is responsible for coordinating tactical and logistical helicopter missions at the incident and reports to the Air Tactical Group Supervisor. This position can be airborne or ground-based with one or more assigned to an incident, depending on the number and type of missions to be accomplished.

Helicopter Inspector Pilot – Helicopter Inspector Pilots (HIP) evaluate the capabilities of private contractor pilots to perform point-to-point transportation of personnel and cargo, as well as special use skills such as fire suppression, retardant delivery, long line vertical reference, rappel operations, aerial ignition, search and rescue, and precision high and low level reconnaissance activities associated with natural resource missions.

Interagency Aviation Training Steering Committee (IATSC) - The committee acts under the charter approval of the National Interagency Aviation Council. The purpose of the Committee is to provide advice, technical assistance, evaluation, and oversight to those agencies conducting and coordinating interagency training modules.

Incident Management Team - The incident commander and appropriate general and command staff personnel assigned to an incident.

Mishaps (Aviation) – A mishap is an unplanned, unintended event involving aircraft operations that results in damage to aircraft, injuries to personnel, or presents the potential for such. Mishaps include aircraft accidents, serious aircraft incidents, aircraft incidents, aviation hazards, and aircraft maintenance deficiencies.

National Incident Management Organization (NIMO) -The National Incident Management Organization is composed of seven member incident management teams with complex fire management as the primary focus of their positions.

National Wildfire Coordinating Group (NWCG) - A group formed under the direction of the Secretaries of the Interior and Agriculture to improve the coordination and effectiveness of wildland fire activities and provide a forum to discuss, recommend appropriate action, or resolve issues and problems of substantive nature.

Office of the Inspector General (OIG) – An independent agency that performs audits and investigations of the Department's programs and operations.

Original Equipment Manufacturer – OEM - Equipment provided by the original aircraft manufacturer.

Operations Section Chief (OSC1 or OSC2) - This ICS position is responsible for supervising the Operations Section, reports to the Incident Commander and is a member of the General Staff. This position may have one or more deputies assigned.

Practical Test Standards (PTS) – Practical Test Standards are being developed as a standard to be used by Forest Service and interagency Helicopter Inspector Pilots when conducting flight evaluations of contractor pilots for natural resource and wildland fire missions.

Strike Team Leader (STCR, STDZ, STEN or STPL) - The ICS position responsible for supervising a strike team. The position reports to a Division/Group Supervisor or Operations Section Chief. This position may supervise a strike team of engines (STEN), crews (STCR), dozers (STDZ) or tractor/plows (STPL).

Task Force Leader (TFLD) - The ICS position responsible for supervising a task force. This position reports to a Division/Group Supervisor or Operations Section Chief.

Title 14: Aeronautics and Space - Part 27—Airworthiness Standards: Normal Category Rotorcraft – Prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for normal category rotorcraft with maximum weights of 7,000 pounds or less and nine or less passenger seats.

Title 14: Aeronautics and Space - Part 29- Airworthiness Standards: Transport Category Rotorcraft.

> (a) This part prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for transport category rotorcraft.
>
> (b) Transport category rotorcraft must be certificated in accordance with either the Category A or Category B requirements of this part. A multiengine rotorcraft may be type certificated as both Category A and Category B with appropriate and different operating limitations for each category.
>
> (c) Rotorcraft with a maximum weight greater than 20,000 pounds and 10 or more passenger seats must be type certificated as Category A rotorcraft.
>
> (d) Rotorcraft with a maximum weight greater than 20,000 pounds and nine or less passenger seats may be type certificated as Category B rotorcraft provided the Category A requirements of Subparts C, D, E, and F of this part are met.

(e) Rotorcraft with a maximum weight of 20,000 pounds or less but with 10 or more passenger seats may be type certificated as Category B rotorcraft provided the Category A requirements of §§29.67(a)(2), 29.87, 29.1517, and subparts C, D, E, and F of this part are met.

(f) Rotorcraft with a maximum weight of 20,000 pounds or less and nine or less passenger seats may be type certificated as Category B rotorcraft.

Appendices

Appendix A - Project Team Members
Appendix B - 2008 Systems Safety Aviation Guide, Tab 5
Appendix C - Hazards and Mitigation Measures Developed by SMEs
Appendix D - Draft Practical Test Standards
Appendix E - Draft of a Standardized Safety Briefing/Oral Evaluation for Personnel Transport in Type 1 Helicopters
Appendix F - Risk Assessment for US Forest Service Heavy Helicopter (Type 1) Personnel Transport
Appendix G - Incident Aviation Management Position Shortage Issue Paper
Appendix H - Rappel Helicopter Screening And Evaluation Board (RHSEB)
Appendix I - Additional Information from SME
Appendix J - Federal Aviation Administration's (FAA) Advisory Circular 120-92

Appendix A

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Appendix B

2008 Systems Safety Aviation Guide, Tab 5

System Safety Assessment - Helicopters

Helicopter System -Aircraft

		Pre-mitigation			Mitigation	Post-mitigation		
Sub-System	Hazards	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)

		Pre-mitigation			Mitigation	Post-mitigation		
Sub-System	Hazards	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)

		Pre-mitigation			Mitigation	Post-mitigation		
Sub-System	Hazards	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 Likelihood	Pre-mitigation Severity	Pre-mitigation Outcome	Mitigation	Post-mitigation Likelihood	Post-mitigation Severity	Post-mitigation 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 attiitudes.	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 Likelihood	Pre-mitigation Severity	Pre-mitigation Outcome	Mitigation	Post-mitigation Likelihood	Post-mitigation Severity	Post-mitigation 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 Likelihood	Pre-mitigation Severity	Pre-mitigation Outcome	Mitigation	Post-mitigation Likelihood	Post-mitigation Severity	Post-mitigation 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 Likelihood	Pre-mitigation Severity	Pre-mitigation Outcome	Mitigation	Post-mitigation Likelihood	Post-mitigation Severity	Post-mitigation 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 supervison 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

		Pre-mitigation			Mitigation	Post-mitigation		
Sub-System	Hazards	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

		Pre-mitigation			Mitigation	Post-mitigation		
Sub-System	Hazards	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

		Pre-mitigation			Mitigation	Post-mitigation		
Sub-System	Hazards	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

Appendix C

Hazards and Mitigation Measures Developed by SMEs

A1 - Due to the size of the interior and door location, it is more difficult to escape in case of accident or incident.

A1M1 - Develop and implement rapid escape procedures

A2 - Ingress and Egress into aircraft is complicated. The management and logistics are more complex dealing with more people and a non-standard seating arrangement.

A2M1 - Identify and implement a standardized interior configuration including seat numbers and seat general location by aircraft model and type.

A2M2 - Ingress and egress should be facilitated by railings, handholds, stairs with defined step height, etc. For each aircraft type, a cabin safety analysis will be done to define the measures and actions needed for personnel to ingress and egress the helicopter. Require an Original Equipment Manufacturer (OEM) passenger loading measures like air-stairs or a ramp on all Type 1 personnel transport helicopters.

A3 - Seat restraints, seats and seat attachments for the aircraft are non-standard in their configuration and meets different minimal legacy Federal Aviation Administration (FAA) standards.

A3M1 - The agency should require all personnel seats are substantiated to PART 29 requirements.

A4 - Non-standardized storage of interior cargo including provisions for approved storage methods of boxes, nets and restraints.

A4M1 - The agency should utilize FAA standards for a restraint system. The agency should develop a location schematic and size standards by model and type.

A5 - Limited visibility exists from inside of the cabin, which restricts the ability of the helicopter manager to assist in identifying external hazards.

A5M1 - Utilize at least one observer bubble window on each side of the aircraft closest to exit doors with intercommunication system access capabilities.

A5M2 - Wire strike kits will be required if available.

A6 - Notification of personnel during emergency who do not have helmets with audio for contact.

A6M1 - The agency should utilize a personnel notification system such as a public address system, horn or siren to alert personnel of emergency. Activation of the personnel notification system should be possible by the helicopter manager as well as the flight crew.

A7 - The loss of 19 passengers from an accident on a single flight in a Type 1 helicopter is perceived to be a greater hazard than the loss of a lesser number of passengers in a Type 2 or a Type 3 helicopter.

A7M1 - Apply appropriate standards regardless of the type and certification standards of the helicopter. The number of personnel will be determined by the performance of the aircraft.

PG1 - The ingress and egress into aircraft is more complicated due to the multiple different configurations of doors and stairs.

PG1M1 - The agency should require an Original Equipment Manufacturer (OEM) passenger loading measures like air-stairs or a ramp on all Type 1 personnel transport helicopters. Identify a standardized door configuration by make and model.

PG1M2 - The helicopter manager will review the mission requirements and brief the pilot(s) on the mission profile and planning.

PG2 - Aircraft Maintenance Inspectors (AMI) are less familiar personnel transport cabin configuration requirements for a Type 1 helicopter than other types of helicopters.

PG2M1 - The agency should accelerate training and mentoring of aircraft maintenance inspectors.

PG3 - There is a lack of standardization between helicopter inspector pilots (HIP) regarding pilot evaluation.

PG3M1 - The agency should implement a standardized procedure pertaining to evaluation of contractor helicopter pilots.

PG4 - The load calculation process is more complex for some Type 1 helicopters used in personnel transport.

PG4M1 - Develop an electronic load calculation and incorporate its use in Helicopter Manager and Crewperson training.

PG4M2 - Place the electronic load calculation process on the Interagency Aviation Training web site.

PG5 - A Type 1 helicopter has a larger footprint requiring a larger helispot. A longer and wider departure and arrival path is required.

> *PG5M1 - Insure there is an adequate approach and departure standard. Adhere to the Interagency Helicopter Operations Guide (IHOG) standards.*

PG6 - A Type 1 helicopter has a greater rotor wash than Type 2 or 3 helicopters.

> *PG6M1 - The agency should insure adequate dust abatement. The agency should insure ground personnel are outside of an adequate safety circle.*

PG7 - There is an element of complexity resulting from mission switch between water or retardant delivery to personnel delivery.

> *PG7M1 - The helicopter manager shall examine and brief the pilot(s) on the mission profile and planning. The HIP shall emphasize the issues related to mission change, particularly from external load to personnel transport. Utilize the electronic load calculation process for each mission.*

PG8 - Incident Management Teams (IMTs) may not be fully aware of how to plan for and utilize Type 1 personnel transport in Operations. Some IMT including NIMO teams do not staff air operations positions. There is an overall shortage AOBD, ASGS, ATGS, HLCO and helibase managers (HEBM). There is a lack of general knowledge including risk assessment and hazard mitigation by the IMT.

> *PG8M1 - Adjust and develop USFS Pacific Southwest Region S-370 course, Intermediate Air Operations in a nationally adopted course. Suggested attendance is Crew Boss (CRWB) and higher including currently qualified personnel.*

> *PG8M2 - The agency should increase it capacity in aviation management positions by staffing three Type 1 exclusive-use helicopters to train staff in advanced aviation management skills.*

> *PG8M3 - Require aviation management staffing on Incident Management Teams including NIMO teams. Staffing should be appropriate for the complexity of incident.*

PG9 - There is an agency need for an adequate number of Aircraft Maintenance Inspectors (AMI) that have specialized training and experience with the Type 1 helicopters.

> *PG9M1 - The agency should implement the optimal number of AMI positions and skills needed based on workload defined by the program of work.*

PG10 - There is an agency need for adequate number of Helicopter Pilot Inspectors (HIP) that have specialized training and experience with the Type 1 helicopters.

PG10M1 -The agency should identify and implement the number of HIPs and skills needed based on workload defined by the program of work.

PG11 - There is a need to establish a practical test standard for a Type 1 pilot check ride for passenger transport.

PG11M1 - The agency should determine and implement a change to the interagency practical test standards for pilots of Type 1 helicopters performing personnel transport missions. Establish a standardized Safety Briefing/Oral Evaluation for pilots transporting personnel in Type 1 helicopters.

PG12 - There is a limited ability for Crew Resource Management (CRM) to occur due to the placement of interior walls in all Type 1 helicopters.

PG12M1 - The agency should establish the capability to permit mobility of helicopter managers while in flight in Type 1 helicopters leading to improved crew resource management.

PG12M2 - Exclusive-use Helicopter Managers will be required to attend Crew Resource Management (CRM) training (16-hour version).

PC1 - Establishing and documenting the center of gravity and weight and balance calculations are critical steps to support mission planning and implementation.

PC1M1 - The vendor will provide the center of gravity and weight and balance limitations for internal cargo maximum weight. All multi-engine aircraft shall perform a weight and balance calculation prior to every takeoff when transporting personnel.

PC2 - Transporting passengers is can be an infrequent mission for most Type 1 helicopter pilots. In general, pilots are not familiar with changing types during a day. Personnel transport requires a different flying technique than other Type 1 helicopter missions.

PC2M1 - The agency should work with other agencies to determine and implement a change to the interagency practical test standards for Type 1 personnel transport helicopters.

PC3 - Crew Resource Management (CRM) is different in a Type 1 due to limited visibility and limited site access to pilots.

> *PC3M1 - The Pilot in Command (PIC) and Second in Command (SIC) will be required to attend Crew Resource Management (CRM) or equivalent training (16-hour version) every contract cycle.*

PC4 - Contractors used for Type 1 personnel transport in the wildland fire environment may not have extensive experience in the personnel transport mission.

> *PC4M1 - The agency should complete an independent aviation audit of Type 1 operators that perform personnel transport to determine the depth and quality of the operators' background and experience in performing this mission.*

O1 - Incident Management Teams (IMTs) may not be fully aware of how to plan for and utilize Type 1 personnel transport in Operations. Some IMT including NIMO teams do not staff air operations positions. There is an overall shortage AOBD, ASGS, ATGS, HLCO and helibase managers (HEBM). There is a lack of general knowledge including risk assessment and hazard mitigation by the IMT.

> *O1M1- Adjust and develop USFS Pacific Southwest Region S-370 course, Intermediate Air Operations in a nationally adopted course. Suggested attendance is Crew Boss (CRWB) and higher including currently qualified personnel.*

O2 - The agency lacks a process to evaluate helicopters used in personnel transport missions. Budget constraints limit the ability of the agency to select optimal aircraft and appropriate support staff for the passenger transport mission.

> *O2M1 - The agency should establish and implement an evaluation process for platforms for Type 1 personnel transport platforms.*
>
> *O2M2 - Establish and implement required program support personnel positions.*
>
> *O2O3 - Establish and request an adequate budget to implement the requested program.*

Appendix D

Draft Practical Test Standards

TASK: HOVER OUT OF GROUND EFFECT POWER CHECK

PILOT OPERATION

1 **Objective.** To determine that the applicant:

a) Exhibits knowledge of the elements related to a vertical takeoff to a hover OGE and landing from a hover OGE.
b) Positions the helicopter in the vicinity of the takeoff point and in the direction of takeoff.
c) Ascends to and maintains OGE hovering altitude, and descends from OGE hovering altitude in headwind, crosswind, and tailwind conditions.
d) Maintains RPM within normal limits.
e) Establishes OGE hovering altitude, ±5 feet.
f) Avoids conditions that might lead to loss of tail rotor/antitorque effectiveness.
g) Keeps forward and sideward movement within 2 feet of a designated point, with no aft movement.
h) Descends vertically to within 2 feet of the designated touchdown point.
i) Maintains specified heading, ±10°.
j) Does not exceed any helicopter operating limitation.
k) Makes smooth and coordinated control inputs.
l) Determines that the power required does not exceed the power available.
   i) For multi-engine helicopters determine if single-engine hover capability exits
   ii) For helicopters requiring more than one pilot, the pilot not flying performs proper crew coordination functions.
      (1) Monitoring torque and operating limitations..
      (2) Warnings before exceeding any operating limitation.
      (3) Assisting with clearing the helicopter.
      (4) Offering of other appropriate assistance not requested by the pilot flying.
   iii) If helicopter performance is sufficient to complete the mission.
   iv) If sufficient fuel exists to complete the mission
   v) Ensure no helicopter operating limitations are exceeded.
   vi) Uses good judgment in making a competent decision on whether the required performance is within the operation limitations of the helicopter.
m) Will not attempt the tasks or task elements listed below when HOGE power is not available and adjust the mission, as required:
   i) Firefighter Passenger Transport
   ii) External load operations.
   iii) Retardant/Water dropping.
   iv) Special use flights below 500’ AGL
   v) Decelerations below ETL or slowing below speeds given for any critical wind azimuths when OGE.
   vi) Confined area, pinnacle and ridgeline operations.
   vii) Any task requiring hovering flight in OGE conditions.

Draft

n) Understands the concepts of Mountain Flying:
   i) Recognition of winds (contour crawl)
   ii) Effects of terrain
   iii) Steep approach vs. Shallow

o) Understands the concept of Confined Area Operations:
   i) Helispot selection (include manager for approval)
   ii) Approach hazards (gross weight, settling with power)
   iii) Gross weight approaches and departures (emergency LZ)

p) Understands the concepts of Pinnacles and Ridgeline Operations
   i) Helispot selection (include manager for approval)
   ii) High and low recon
   iii) Approach hazards (windward vs. leeward)
   iv) Crew guidance for helispot improvements (suitability)
   v) Gross weight approaches and departures (emergency LZ)
   vi) Parallel vs. perpendicular to ridge (winds, emergency LZ)

q) Understands the concept of Slope Operations
   i) Unimproved helispots (suitability marginal)
   ii) Limitations (aircraft and human)
   iii) Dynamic Rollover (recognition and recovery)

Draft

TASK: FIREFIGHTER PASSENGER TRANSPORT

PILOT OPERATION

1 **Objective.** To determine that the applicant:

a) Exhibits knowledge by explaining the elements of takeoffs from and approaches to confined area, pinnacle or platform operations.

i) For multi-engine and transport certificated helicopters exhibits knowledge of Category A and Category B flight operations.

ii) For single engine and multi-engine, transport and utility certificated helicopters, exhibits knowledge of Hover-Out-of-Ground-Effect (HOGE) power check procedures and determination if power available is sufficient for power required for takeoff.

b) Computes weight and balance, including adding, removing, and shifting weight, and determines if the weight and center of gravity will be within limits during all phases of flight.

c) Demonstrates proficient use of load calculations for the mission locations with reference to the correct performance charts and current weight and balance information.

d) Describes the effects of atmospheric conditions on helicopter performance.

e) Uses good judgment in making a competent decision on whether the required performance is within the operation limitations of the helicopter.

f) Exhibits knowledge of a thorough pre-flight briefing of firefighter passenger

2 **Action.** The inspector will:

a) Ask the applicant to explain the elements of the HOGE power check operations and determine that the applicant's knowledge meets the objectives.

b) Ask the applicant to perform the HOGE power check operation and determine that the applicant's performance meets the objectives.

c) Ask the applicant to explain the items listed in Firefighter Passenger Transport

DRAFT

Appendix E

Draft of a Standardized Safety Briefing/Oral Evaluation for Personnel Transport in Type 1 Helicopters

DRAFTTALKING POINTS

Personnel Transport in Type I Helicopters

- **External Load vs Internal Load & Passenger Operations**

  Mindset *(making the mental adjustment to passenger transport)*
  Flight Planning *(downloads, HIGE vs HOGE considerations, etc)*
  Jettisonable vs Non-Jettisonable *(implications, no more production mindset)*
  Crew / Passenger Comfort *(if one is uncomfortable all are uncomfortable*

- **Crew Coordination:**

  Briefings *(mission, crew & passenger, etc)*
  Decision Making *(Include HMGB; the question is not "can we" but rather "should we")*
  Loading & Unloading of Passengers (*differs from anything they have experienced)*

- **Mountain Flying:**

  Recognition of Winds *(contour crawl, 40 knot pass, etc)*
  - Effects of Terrain *(turbulence, demarcation line, etc)*

  Power Management *(including knowledge of powercheck procedures)*
  Shallow vs Steep Approach *(rate of descent, large power changes, etc)*

- **Confined Area Operations:**

  Helispot Selection *(include HMGB in process)*
  High & Low Reconnaissance *(don't talk about it, do it)*
  Approach Hazards *(gross weight, density altitude, settling with power, LTE, etc)*
  Crew Guidance for Helispot Improvements *(debris, required clearances, etc)*
  Loading & Unloading of Gear and Passengers *(direction & distance from aircraft)*
  Gross Weight Approaches & Departures *(do you have an emergency LZ, etc)*

Draft

DRAFTTALKING POINTS

Personnel Transport in Type I Helicopters

- **Pinnacle and Ridgeline Operations:**

  Helispot Selection *(include HMGB in process)*
  High & Low Reconnaissance *(don't talk about it, do it)*
  Approach Hazards *(density altitude, erratic winds, windward vs leeward)*
  Crew Guidance for Helispot Improvements *(debris, required clearances, etc)*
  Loading & Unloading of Gear and Passengers *(direction & distance from aircraft)*
  Gross Weight Approaches & Departures *(do you have an emergency LZ, etc)*
  Parallel vs Perpendicular to Ridge *(wind considerations, emergency LZ, etc)*

- **Slopes:**

  Unimproved Helispots *(suitability for wheeled and/or tanked aircraft)*
  Limitations *(aircraft & human)*
  Dynamic Rollover *(recognition & recovery)*
  - Human Factors *(significantly different capabilities from skid aircraft)*

- **Situational Awareness:**

  Crew Communications *(use of crew and passengers)*

Draft

Appendix F

Risk Assessment for US Forest Service

Heavy Helicopter (Type 1)

Personnel Transport

Risk Assessment

for

US Forest Service

Heavy Helicopter (Type 1)

Personnel Transport

Conducted by
Fire Program Solutions
in conjunction with
Baldwin Aviation

INTRODUCTION

The purpose of this study is to conduct a "risk assessment for personnel transportation in Type 1 helicopters". The goal of any risk assessment to is to identify and mitigate hazards associated with a particular operation. Hazards are acts or conditions with the potential to cause 1) injury, disability or performance degradation to people or 2) damage to equipment, property or the environment. However, in this case, the focus is on personnel transportation, which, per the solicitation, limits the scope of acts or conditions with the potential to cause injury, disability or performance degradation.

Risk has a formal definition. It is the product of the *probability* (or likelihood) that a hazard will occur and *severity*, which is the worst credible (not the worst possible) outcome that could occur. This risk assessment will consider both aspects. That is, the study will look at ways to reduce (*mitigate*) the probability that a hazardous act or condition will cause injury and, should one occur, ways to minimize the severity of the potential injury.

In this risk assessment both severity and probability have three subjective levels assigned to them. They are:

Probability

Low	rare, once a year
Medium	occasionally, several to many times a year
High	likely, once per flight or once per day

Severity

Low	first aid type injury, no lost work time
Medium	OSHA recordable event, lost work time
High	serious injury, death

This creates a simple three-by-three matrix (see figure 1). When the subjective values are plotted on the matrix the resulting risk is identified. Any risk in the red band (numbers 1 and 2) requires a stop work order. Work will cease until mitigation lowers the resulting risk out of the red band. Any risk that is in the yellow band (number 3) can continue, with management approval and oversight, however a long-term solution should be placed in work to mitigate the hazards into the green band. A risk that falls in the green area (numbers 4 and 5) can continue without oversight but any hazards identified must be corrected.

Mitigation falls into two broad categories. The first is *corrective* action. This is an immediate fix to prevent injury. Stop work! is a corrective action. Relieving a tired pilot before the end of shift is a corrective action. *Preventive* actions are long-term solutions to a hazardous act or condition. This may require changes to procedures or practices.

		SEVERITY		
		High	Med	Low
PROB.	High	1	2	3
	Med	2	3	4
	Low	3	4	5

Figure 1. Risk Assessment Three-By-Three Matrix

When considering mitigating actions, there are ways to reduce the probability the event will occur as well as ways to reduce the severity should the event occur. Stop work is reducing the probability. Personal protective equipment reduces the potential severity.

In general, there are three types of mitigating actions. Engineering controls eliminate the hazard. This is the most desirable control. A "one way" installation design is an example of an engineering control to prevent incorrect placement. Administrative controls place restrictions on the issue. Flight time and duty limits are an example of admin controls for fatigue. The third, and least desirable, are coping methods, such as training, Personal Protective Equipment, briefings, etc. These can be forgotten, ignored or otherwise not used so they are less effective.

Any type of mitigation should be as specific as possible. For example "improving a remote helispot" is not very specific. However, "reducing all brush, rocks and other obstacles to half the skid height or half the distance from the ground to the bottom of the tail rotor arc, whichever is lowest" is much more specific and provides detailed guidance to the person required to manage the mitigation.

More than one corrective or preventive action may be suggested or developed for a given hazard. In fact this is desirable. All mitigation should be evaluated on a cost~benefit matrix (Figure 2).

This is very similar to the risk assessment matrix. Again, these are subjective values but with definitions.

Cost

Low	very inexpensive, pennies
Medium	moderate, hundreds of dollars
High	expensive, tens or hundreds of thousands of dollars or more

Benefit

High	instant, positive improvement
Medium	some improvement but not ideal
Low	little or no improvement

		BENEFIT		
		High	Med	Low
C				
	Low	1	2	3
O				
	Med	2	3	4
S				
	High	3	4	5
T				

Figure 2. Cost~Benefit Matrix

The "polarity" of the matrix is slightly different than the risk assessment. That is something that is *low* cost but with a *high* benefit is the most desirable (green band, numbers 1 and 2). Conversely, and obviously, anything with a high cost and low benefit is undesirable at best, and impractical, at worst (red band, numbers 4 and 5). Mitigations in the yellow band, number 3, are a management call. In some situations, that might be the only solution. In any case, all potential mitigations, however impractical, should be listed, evaluated and documented. Green band solutions (numbers 1 and 2) are the best.

If you find there are multiple solutions they can be evaluated further. Other considerations beyond cost and benefit include:

- Effectiveness — Is the hazard eliminated or controlled?
- Ease of introduction — Is training or hardware required?
- Acceptance — Will users, customers or management object?
- Durability — Will this fix stand the test of time?
- Enforceability — How can you be sure this will be done?

And finally, you must consider both *residual risk* and *substitute risk*. *Residual risk* is the risk left over after mitigation is implemented. This must be considered and addressed if the risk is still in the yellow band. This is particularly important for hazards identified that are located I the green band. Even though that is a "go", from a mission standpoint, the hazards are still there and must be addressed.

Substitute risk is any hazard that is introduced or created by the primary mitigation effort. For example, basic hearing protection used in a high noise environment limits or eliminates communication, which might be necessary to prevent injury or damage. So, corrective/preventive action (such as hand signals) must be created to work around the primary mitigation.

In summary, the risk assessment has the following components:

- Hazard
- Probability
- Severity
- Risk
- Mitigation
- Resulting Probability
- Resulting Severity
- Resulting risk
- Cost
- Benefit
- Cost/Benefit value
- Residual Risk
- Substitute Risk

Appendix G

Incident Aviation Management Position Shortage Issue Paper

Incident Aviation Management Position Shortage

Issue Paper

Jill McCurdy, National Aviation Training Specialist
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Issue

Lack of qualified HEB1, ASGS, and AOBD's to fill critical incident management positions

Introduction

Filling HEB1, ASGS, and AOBDs positions with qualified individuals on Incident Management Teams or as single resources is becoming increasingly difficult. Historically, a large number of qualified individuals came from the "militia"---other resource disciplines who cross-trained to fill fire management needs during the fire season. Candidates now likely to transition into these positions are often drawn from a pool of expertise ranging from helicopter foreman (exclusive use programs), high- experience Call-When -Needed helicopter managers, Forest Aviation Officers (FAOs), and Fire Management Officers (FMOs) or their Assistants (AFMOs). In the past aviation expertise was needed to fill occasional roles on Incident Management Teams during peak fire season. The need for HEB1, ASGSs and AOBD has evolved from an "occasional assignment" to numerous, or season long fire assignments with occasional dispatches for FEMA or other Homeland Security support roles outside of the traditional fire season. The role of incident management teams has expanded to take on more complex issues such as protection in an environment with increasing amounts of wildland- urban interface where fire behavior has become notably more extreme and resistant to routine strategies and tactics. Making a long-term commitment to an Incident Management Team to manage aviation operations under these circumstances has become more than an occasional assignment; instead it is more like a "life sentence". To make such a commitment requires support from unit line officers, adequate funding for recurrent training, and personal adaptability and flexibility in meeting the demands of various types of assignments in various geographic locations.

This document is presented to identify current barriers to filling the shortage positions with qualified individuals and seeks to provide recommendations that may warrant further dialogue. The following is a list of identified issues that may have contributed, and continue to contribute to the current shortage of qualified people to fill HEB1, ASGS, and AOBD positions:

Issues/Barriers

1) Workforce/Organizational Changes

Fire organizations providing the personnel that once supported these positions have changed dramatically with organizational re-structuring. Fire and aviation programs at regional, forest and unit levels have become more complex as funding is stretched and fire and aviation managers are continually assigned collateral duties at their host units. In addition, current statutory requirements complicate manager tasks in the areas of financial management, acquisition, information technology, and accountability. Staffing and funding for these support functions has become centralized and as a result, fire and aviation managers face the growing list of unit demands with diminished capabilities.

Task saturation at these levels has resulted in (in some cases) next-in-line supervisors—the helicopter program mangers, engine captains, crew superintendents, etc., assuming a larger role in the management of their individual programs at the unit level. Responsibilities associated with program oversight at a home unit limits the availability of some qualified people to participate in training assignments when opportunities arise. And even fewer are able to make a commitment to an Incident Management Team. In fact, many ASGS and AOBD roles on teams are filled with individuals willing to commit to a "job-share" rather than a primary role.

Funding shortages also require units to limit and prioritize training. In some cases that training is limited to those functions that are only necessary for the employee to fulfill requirements for their position or appointment. As an example, aviation training for an FMO may not be the priority for that position, and may not be supported. Additionally, units may fund and support training for individuals to help meet resource management needs on the home unit (such as Helibase Manager qualifications necessary to meet various helitorch position requirements), but require those individuals to remain at the home unit to staff engines or IA crews during the fire season.

Action - Promote development through establishment and support of assistant unit aviation officer positions on units with complex programs. Developing our future aviation leaders through developmental or assistant positions would help create a workforce capable of responding to future challenges.

Not only would development positions effectively help create a pool of future forest aviation officers, the position would also result in the added bonus of helping to fill critical needs on Incident Management Teams, by either training and mentoring candidates to become qualified as Air Operations Branch Directors (AOBD), Air Support Group Supervisors (ASGS), or Air Tactical Group Supervisors (ATGS), or to free up current forest aviation officers with these qualifications for incident assignments during periods of high-fire activity.

Action - Engage line officers: Meeting the challenge of building future HEB1s, ASGS and AOBDs to fill critical needs involves working collaboratively with Line Officers and fire and aviation leadership to examine and build a workforce that possesses the skills needed to meet emerging demands. It is the agency's responsibility to recruit, train, mentor, and retain a highly skilled aviation workforce at all levels. Aviation leadership requires a commitment to funding training, and proficiency regardless of budget ebbs, and flows. This will allow our agency to provide a well-trained mission ready workforce, as stated in doctrine.

2) Lack of Incentives

There appears to be a lack of incentives to attract interested individuals with a good balance of skills necessary to perform the functions associated with the positions. Incentives include financial, professional development, and opportunity for advancement. There is a significant time and funding commitment to get interested people to the level where they can perform effectively as HEB1, ASGS, and AOBDs. Once the requirements and qualifications are achieved, hazard pay becomes a rarity, and holding these qualifications provides limited benefit in pursuing professional careers in fire and aviation and does not necessarily come with a higher rate of pay. Prior and extensive fireline experience is required for advancement in aviation positions, but aviation skills are not required for fireline positions. Obtaining advanced skills and experience in fireline positions provides a wider range of career opportunities, than do aviation skills, therefore many choose the training route that will provide them with more professional options (there are more fire positions, than aviation positions).

> **Action - Market and promote benefits and opportunities linked to these qualifications:** Develop training plans for interested individuals and engage regional/forest-level support to ensure appropriate training, mentoring, and assignments are supported by line officers and supervisors. Marketing for the positions should focus on building an awareness of job opportunities and provide examples to show that their time and investment is worth the effort.
>
> **Action - Support development of trainees:** People who have demonstrated the "mental and leadership fitness" for these positions need to become party to an internal network that assists their pursuit of permanent or higher level (or next-level) aviation positions.

3) Leadership/ Perception of the job

The complex environment in which we operate requires employees to use technical, interpersonal, and leadership skills in virtually every aspect of the job. Acquiring leadership competencies is essential to confidently managing complex aviation operations on incidents. However, leadership is a topic loaded with assumptions and perceptions. One common assumption is that leadership is laden with the burden of responsibility as well as liability. Because of the complexity that young firefighters are seeing in terms of fire and aviation management, the tendency is to develop biased perceptions about the scope of the responsibility for these positions. The result is reluctant leaders who are more comfortable with being reticent rather than being held liable for a decision made that had an undesirable outcome. Others have experienced leadership when put in a situation where they had no choice but to lead--and would not have aspired to such a without being in those circumstances. Motivating people to lead through mentoring, training, and providing opportunity, is the most effective way to encourage potential candidates to make the transition to HEB1, ASGS, and AOBD positions.

Additionally, filling the skills gap between line and supervisory positions is equally difficult. Making the leap from ground positions, "where the work gets done" to positions that require responsibility to "supervise the work that gets done" can be intimidating, unexciting, and tedious. Given the skill set needed to manage aviation resources safely and effectively, many firefighters make a conscious decision not to participate.

> **Action - Influence perceptions through mentoring/training programs**
> The limited availability of qualified people makes it clear that our traditional recruiting, training, and mentoring processes are not resulting in the production of HEB1, ASGS and AOBD candidates at the rate in which it is needed. We need to recognize the value of our experienced aviation workforce and capitalize on opportunities to pair experienced people with trainee or developmental positions. Development of formal training and mentoring programs that commit to prepare subordinates to become our next generation leaders is needed. This will effectively fill skill gaps, promote interest and encourage likely candidates to make the transition into HEB1, ASGS and AOBD positions.
>
> Mentoring should focus on building skills, confidence and professional interest. Well-designed mentoring programs can effectively mesh necessary technical and leadership skills as well as enhance employee awareness of the functions and responsibilities associated with the job.

4) Incident Management Team configuration

To address the AOBD shortage in particular, the reasons may vary among geographic areas. In some Regions, the AOBD position within an IMT's organization is present within the structure of both Type I and II Teams. In other GA's, the AOBD position is only held on Type 1 Teams, with ASGS's being the leading aviation management slot on Type II teams. Regions with this arrangement have decidedly not required AOBDs on type II Teams, due to the lack of qualified individuals to fill the positions. If this were to become a requirement, some Regions would be unable to host Type II Teams. In the case of ASGS's on Teams without AOBD's---the ASGS's often assume the AOBD roles and responsibilities without the IQCS qualifications. In this case, ASGS's may not feel the need to acquire the AOBD qualifications due to their current commitment on Type II teams.

Another issue associated with lack of desire to move into AOBD positions is the ICS configuration where AOBDs work for the Ops Section Chief, and are not part of the Command and General Staff (CGS). The complexity of air operations on incidents has reached the use and complexity level where some current AOBD and ASGSs believe it warrants an additional CGS position for Air Operations. Being able to dialogue and develop strategies and tactics on an "equal" playing field rather than as a subordinate member would help promote the importance of the position.

Fire Use Management Teams (FUMTs) and Type 3 organizations do not carry aviation positions within their team configuration, yet these types of events typically utilize aviation assets to monitor and conduct point protection in accordance with developed strategies and tactics.

Action - Incident Management Team recruitment: Incident Management Teams need to take a proactive role in recruitment to fill training slots for these positions. Seeking individuals with base skills that are interested in transitioning into these types of positions, and then developing a formal agreement to include mentoring and training with the host unit to ensure availability for assignments--would be one effective method to address the need.

Action - Allow flexibility in IMTs configurations: Allow Incident Management Teams (Type I, II and FUMTs) the flexibility to carry HEB1, ASGS, and AOBD positions, to include trainee positions, when appropriate. This flexibility would allow more "openings" and therefore more training platforms to "grow" more aviation managers.

Action - Explore current ICS structure and consider repositioning AOBD as Command and General Staff.

Summary

Accomplishing our mission requires the focus and support of management at all levels of the organization. Changes in staffing have been identified as a contributor to the agency's diminishing ability to address the increasing complexities of fire and aviation management both at the unit level and on Incident Management Teams. Organizational changes combined with the current attrition rate have contributed to mid-level supervisory gaps. In response to organizational changes, Regions, Forests, and districts need to position themselves to better meet future needs through development and promotion of employees that acquire the skills necessary to meet the organizations goals and missions they support. Success will require efficient resolution of issues, flexibility to adapt to changing conditions, identification of new opportunities, and capitalizing on those opportunities.

Appendix H

Rappel Helicopter Screening And Evaluation Board (RHSEB)

Abstract

Without having a formalized, methodical evaluation procedure, the Rappel program does not have a formal way of assessing non-traditional helicopters for rappel platforms, and this deficiency affects the safety and efficiency of the program. However, the Smokejumper program has an active committee, Smokejumper Screening and Evaluation Board (SASEB), which constantly assesses new aircraft, and updates accessories, following standardized specifications. The Rappel program can easily establish a nationally recognized committee, Rappel Helicopter Screening and Evaluation Board (RHSEB), by incorporating the basic structure of SASEB's charter and plan adding essential, functional requirements critical to rappel platforms. Once RHSEB is operating, the Rappel program will have a standardized evaluation procedure that will actively address quality assurance of its evaluation of new aircraft and will eliminate random unit evaluations.

Rappel Helicopter Screening and Evaluation Board

Knowing the importance of a speedy and timely initial attack in steep and inaccessible terrain, the U.S. Forest Service, in 1947, began employing helicopters to fight wildland fires. Because of their capability and maneuverability, helicopters have become a valuable tool within the wildland fire community. From the Bell 47 to the Sikorsky S-61, helicopters have proven to be successful not only for bucket work operations, cargo transport, but also the utilization of the aircraft to deploy firefighters by means of rappel to remote wildfires. The different models of helicopters used as a rappel platform has changed and varied over the past forty plus years; however, the process of evaluating each model as to its safety and acceptability as a rappel platform has been less than perfect. Conversely, the Smokejumper program has a formal process to evaluate and screen smokejumper aircraft, which could very easily be adopted by the Rappel program.

History of Rappellers and Smokejumpers

Realizing the efficiency of helicopters, especially when wind gusts prohibited the use of parachutes, the smokejumpers started experimenting with heli-rappelling. However, due to a near fatal accident, the U.S. Forest Service abandoned the use of helicopters as rappel platforms until the Redmond, Oregon, Smokejumpers reintroduced the helicopter program in 1972; and then in 1973, the U.S Forest Service established two rappel programs: one in Chelan, Washington, and the other at Santiam Airstrip in Oregon. During the summer of 1973, the two *Smokeslider* sites successfully rappelled 26 fires, the first rappel occurring on July 21, 1973. Seeing the positive aspects of rappelling, the U.S. Forest Service recognized Rappellers as a separate entity from the Smokejumpers (rappel-in.com, 2008). Over the past 40 years there have been 13 different types of helicopters used as a rappel platform and currently 9 helicopters are approved as rappel platforms (U.S. Forest Service, 2006).

The history of the Smokejumper entity is very similar to that of the Rappel's. Again, the U.S. Forest Service started two programs: one in Winthrop, Washington, and the other in Moose Creek, Montana. Both programs were very successful the first year, jumping nine fires with the first fire jump happening on July 12, 1940. The two smokejumpers, who parachuted to the high-terrain fire within the Nez Perce National Forest of Idaho, were Rufus Robinson and Earl Cooley. Presently, the

Smokejumper program uses 12 different types of fixed wing aircraft as smokejumping platforms (U.S. Forest Service, 2001).

Although the Smokejumper and Rappel entities are similar in many ways, the Smokejumper program has established a standardized procedure for the aircraft that it utilizes for smokejumper operations. The Smokejumper program established the Smokejumper Screening and Evaluation Board (SASEB), which oversees and manages a formal systematic process for evaluating potential smokejumper aircraft. Unfortunately, however, the Rappel program does not possess a formal evaluative process. If a helicopter were to come into the rappel market, at this time, the program would not be able to perform a standardized screening and evaluation of that "new" helicopter; instead, local units would complete the evaluation according to a non-formal process. Therefore, it is imperative for the Rappel program to create a Rappel Helicopter Screening and Evaluation Board (RHSEB), whose sole responsibility would be to develop a standardize, formal evaluation procedure, that would methodically scrutinize all requirements necessary to guarantee safety and efficiency. Consequently, since the Smokejumper Aircraft Screening and Evaluation Board (SASEB) is a proven process, and since comparisons between smokejumper aircraft and rappel helicopters are very similar, it will be feasible to utilize the SASEB charter as foundation for establishing RHSEB.

The same objectives for the SASEB are also specifically applicable to the employment of "new" rappel helicopters as well. Therefore, the development of RHSEB will be presented with the focus on objectives in prospective to the goals and objectives of RHSEB.

A) New rappel helicopters need to have a standard aircraft and evaluation plan. The SASEB plan could be used as a template to the RHSEB.

B) The criteria, engineering data, and procedures for the testing and evaluation between the two platforms are very similar. However, the RHSEB has four additional functions that it must evaluate:

1. Mandatory Criteria: The need to verify if aircraft is Federal Aviation Administration (FAA) certified as a normal or transport aircraft and if it is FAA approved to fly with the doors open or removed if required for the mission.

2. Administrative Considerations: The need for specifications from the rappel aircraft, number of rappel aircraft potentially for government contracts, estimated contract rate, date of certification and last manufacture, and maintenance requirements.

3. Flight Performance Data: The need to calculate the center of gravity limits, rappel doors, payload capabilities, and maximum airspeed is required.

4. Rappel/ Cargo Let-Down Functional Suitability Data: The need to evaluate rappel anchor, spotter tether, related accessories, flight and environmental characteristics with door removed, potential conflict with rappel operations, is aircraft clean around the door, pilot/ spotter view and overall adequate visibility, amenability to installation of standard communications package, cubic inches of cargo space internally adequate, cabin volume, and provisions for restraint of cargo is essential.

C) The aircraft must have a sponsor before the evaluation board will assess an aircraft. A recognized sponsor is any unit that requests a rappel aircraft on site and wants an evaluation done on a new aircraft. The sponsor must provide preliminary information to the RHSEB chairman.

D) Upon completion of the evaluations, RHSEB will create a final report and will conclude whether the aircraft qualifies for the Rappel Helicopter Approved Aircraft List. Because there is no formal list at this time, RHSEB will need to create a Rappel Helicopter Approved Aircraft List, and the RHSEB will need to determination if current rappel platforms can be "grandfathered" to determine whether or not the aircraft can be added to the Rappel Helicopter Approved Aircraft List or not.

E) Overall safety and efficiency is a key component of RHSEB. New technologies and aircraft accessories are improving the aircraft's safety and efficiency in a variety of ways. Thus, the board needs to request information when industry creates new improvements or accessories so that the Rappel program can continually improve its overall evaluation.

F) Once the industry gives RHSEB information concerning the ability of new accessories and aircraft improvements, the board will need to prioritize the ongoing development. However, if aircraft improvements and new accessories are in question as to meeting the specifications outlined by RHSEB, the Rappel Equipment Group (REG) or the Rappel Working Group (RWG) should make the request.

G) The rappel community must constantly be reviewing and evaluating the equipment, procedures, aircraft, and accessories. Immediate concerns need to be brought to the RHSEB, and then the RHSEB can assess the issues and determine the corrective actions needed. The corrective action could range from minor alterations to removal of the aircraft from the Rappel Helicopter Approved Aircraft List.

H) The RHSEB committee needs to create a manual similar to the SASEB manual, with all of the key objectives outlined by SASEB being the basic key objectives in the RHSEB manual as well.

Over the past 70 years the smokejumper program has created a formal process to evaluate the aircraft that they have as smokejumper platforms. The SASEB has allowed the program to be more efficient as well as provided safety for the firefighters that are exiting those aircraft. It is time that the rappel community utilizes the SASEB template and creates a RHSEB organization to also provide for efficiency and most importantly rappeller safety.

Executive Summary

Presently if there were an accident that involved a rappel platform during rappel operations, an investigation team would inquire as to how these aircraft are being evaluated prior to becoming a rappel platform. The process would be considered inadequate and may allow for the rappel program to be shut down. A plan and charter can be adopted from the Smokejumper program, which gives the ability to provide a more efficient rappel operation, as well as provide safety for the aerial delivered firefighters.

I would like to formally request funding and support to establish a Rappel Helicopter Screening and Evaluation Board (RHSEB). We must be proactive with our rappel program and in order to be an effective, safety oriented and cost conscientious culture we need standardize our helicopter rappel platforms. We are providing a disservice to the rappel program and our employees by not giving them the tools to bring new aircraft into the ranks and expecting them to perform technology and development without the expertise and direction.

With a minimum of $100,000 per year for the next five years I would expect to have the existing fleet of helicopter platforms inspected, approved, and confirmed to be the viable rappel platforms and to provide data to support those findings. In addition we will establish, protocols, standards, and requirements for new and improved platforms that will give this program the best product for the high risk environment that is necessary to perform safe and efficient rappel operations.

Appendix I

Additional Information from SME

A1 - Due to the size of the interior and door location, it is more difficult to escape in case of accident or incident.

A1M1 - Develop and implement rapid escape procedures.

Backgound

In contrast to helicopters in which the agency typically transports passengers (AS350, Bell 206L, 407, 205 and 212), the S61's interior requires the majority of the passenger to go forward or aft before exiting through a cabin door, There are two additional emergency exit windows, one on e ach side, available for egress but require unlatching to open. The other windows on each side are not labeled as exits. The Forest Service has only contracted for CAR 7 Type 1 aircraft to date. The Civil Aviation Regulations (CARs) predating the current 14 CFR Parts that constitute the Federal Aviation Regulations. 14 CFR Part 29.803 requires that the rotorcraft be able to have all passenger evacuated within 90 seconds. CAR 7 does not have a requirement of this sort.

During contract compliance inspections after the S61 accident the required passenger briefing cards did not represent the configuration of the cabin or the passenger restraint system properly depicted. Passenger Briefing cards have to depict the actual configuration of the cabin as well as the seat and restraint configuration. Passengers shall be briefed using these cards in accordance with FAR PART 135 requirements for each passenger flight accomplished. At a minimum, passenger evacuation drills shall be accomplished once the standard seating configuration is determined with a goal of a 90 second evacuation.

A2b- Seat restraints, seats and seat attachments for the aircraft are non-standard in their configuration and meets different minimal legacy FAA standards.

A2bM1 – The agency should require all personnel seats are substantiated to PART 29 requirements.

Floor structure, seats and passenger restraints should all be Federal Aviation Administration (FAA) approved and protect the passenger as much as practicable during a crash. There are multiple variations of FAA approval from the old CAR 7 standard to 14 CFR Part 27 / 29 which are the current rotorcraft certification standards as well as technical standard orders (TSOs) which are minimum performance standards for seats (TSO C39c or 127a), seat belts (TSO C22g) and shoulder harnesses (TSO C114). As allowed by the FAA, all of these standards can be acceptable for aircraft that the Forest Service contracts for.

There are currently only Civil Aviation Regulations (CAR) 7 Type 1 helicopters being offered for contract. These aircraft were certified to withstand the following inertial loads:

- Upward—1.5g
- Forward—4g
- Sideward—2g
- Downward—4g
-

Current standards for Part 27 and 29 rotorcraft are certified to withstand the following inertial loads:

- Upward—4g.
- Forward—16g.
- Sideward—8g.
- Downward—20g, after the intended displacement of the seat device.
- Rearward—1.5g.

The standards as compared reflect how far cabin safety requirements have come. In most cases the load factor is 4 times greater. This says that the passenger and seat combination in a Part 27 and 29 rotorcraft can withstand a crash landing that is 4 times greater than a CAR 7 aircraft.

Additional research found a S61-N accident that took place in July of 1983, which showed that the Original Equipment Manufacturer (OEM) attach points failed on the double seat installations. From this accident the British Department of Transportation, Accident Investigation Branch recommended "the strength of both the passenger and attendant seats should be improved. All of the twin seats inside Oscar November (the accident aircraft) sheared off, whilst the single seats remained fixed. The four surviving passengers were sitting in the single seats." See: http://www.aaib.gov.uk/sites/aaib/cms_resources/8-1984%20G-BEON.pdf

A surviving passenger from that accident described what happened to her: *Mrs Langley-Williams told The Times (20 July 1983, p. 28 & 18 July 1983, p. 26): "It was very quick. I bumped forwards and hit my head on the seat in front." She asked Mrs Smith, '"What the hell is going on?"' The response was one word, by which time the passengers were chest-deep in seawater. "I closed my mouth and took a deep breath and by then I was under water."* ***The seat had twisted on impact, tightening the seatbelt****. "I realized I had not got an awful lot of breath left." She released the belt, opened the door and floated to the surface.*

Taking the above into account, seating installations (which include the attaching structure to the aircraft, the seat installation and seat belt / shoulder harness) for Type 1 helicopters shall be substantiated by the OEM or an appropriately rated FAA Designated Engineering Representative to FAR Part 29 certification criteria.

The scope of the task was the transport of personnel in Type 1 helicopters not including the additional hazards of initial attack or rappelling. The following hazard was identified by the SME and is shown here for completeness of their thoughts.

Hazard - There is a perception that in some areas, this helicopter is too large to be used as an effective initial attack platform due to a lack of adequate unimproved natural helispots.

> *Mitigation - Develop and implement standards and guidelines for use of Type 1 helicopters for passenger transport for initial attack.*

For 2009, the Forest Service anticipates the need to meet with the vendor personnel (Chief Pilot & Director of Operations), the Helicopter Managers, Helicopter Inspector Pilots and the National Office staff to develop standard operating procedures and parameters prior to the start of the contracts this year. Only Travel costs associated with this task ($3500 travel and $1500 per diem).

For the future years, it is imperative that the Forest Service brings together a group consisting of "Operations", "Program Oversight", and "Safety" for the express purpose of developing "Standards and Guidelines for the Deployment of Type I Passenger Transport Helicopters in the Initial Attack Role." This group should consist of several (three to four) highly experienced Exclusive Use Managers (Operations), at least two Regional Helicopter Operations Specialists and one Helicopter Inspector Pilot (Program Oversight), and one Regional Aviation Safety Manager (Safety). An additional consideration is that any group put together should contain a healthy mix of supporters as well as skeptics. Majority participation by individuals with a vested interest in the outcome should be avoided. Once a draft set of standards has been developed they would need to be vetted through WO-W (Both Operations and Safety) for review and implementation.

Cost: Costs associated with these recommendations include an estimate that is under $5,000 (travel, per diem, meeting space, etc). Cost to develop the standards and guidelines is about $10,000.

Appendix J

Federal Aviation Administration's (FAA) Advisory Circular 120-92

Advisory Circular

Subject: Introduction to Safety Management Systems for Air Operators

Date: 6/22/06

AC No: 120-92

Initiated by: AFS-800

1. PURPOSE.

a. This advisory circular (AC):

(1) Introduces the concept of a safety management system (SMS) to aviation service providers (for example, airlines, air taxi operators, corporate flight departments, and pilot schools).

(2) Provides guidance for SMS development by aviation service providers.

b. This AC is not mandatory and does not constitute a regulation. Development and implementation of an SMS is voluntary. While the Federal Aviation Administration (FAA) encourages each aviation service provider to develop and implement an SMS, these systems in no way substitute for regulatory compliance of other certificate requirements, where applicable.

2. APPLICABILITY. This AC applies to both certificated and non-certificated air operators that desire to develop and implement an SMS. An SMS is not currently required for U.S. certificate holders. However, the FAA views the requirements in Appendix 1 to this AC to be a minimum standard for an SMS developed by an aviation service provider.

3. RECOMMENDED READING MATERIAL. The following ACs may be of value to users of this AC if they desire to integrate any of the following programs with an SMS:

a. AC 120-59A, Air Carrier Internal Evaluation Programs.

b. AC 120-66, Aviation Safety Analysis Programs (ASAP).

c. AC 120-79, Developing and Implementing a Continuing Analysis and Surveillance System.

d. AC 120-82, Flight Operational Quality Assurance.

4. BACKGROUND. The modern aviation system is characterized by increasingly diverse and complex networks of business and governmental organizations. The rapidly changing aviation operational environment requires these organizations to adapt continuously to maintain their

viability and relevance. The aviation system is also becoming increasingly global. Few business entities' markets, supplier networks, and operations are confined entirely within the boundaries of a single country. These characteristics of complexity, diversity, and change add to the importance of sound management of functions that are essential to safe operations. While safety efforts in the aviation system have been highly successful to date, the rapid increase in the volume and variety of aviation operations push the limitations of current safety strategies and practices. Along with this trend is the problem of decreasing resources to be applied by both business and government organizations. These processes have forced a fresh look at the safety strategies of the future. The best approach to problems of increased aviation activity and decreased resources is to bring safety efforts into the normal management framework of aviation operations. Just as businesses and government organizations must manage these factors effectively to accomplish their missions or to maintain business viability, they must likewise provide sound management of safety. This innovation in aviation system safety is best termed "Safety Management Systems" a term indicating that safety efforts are most effective when made part of business and government management of operations and oversight.

a. Safety Benefits of an SMS. An SMS is essentially a quality management approach to controlling risk. It also provides the organizational framework to support a sound safety culture. For general aviation operators, an SMS can form the core of the company's safety efforts. For certificated operators such as airlines, air taxi operators, and aviation training organizations, the SMS can also serve as an efficient means of interfacing with FAA certificate oversight offices. The SMS provides the company's management with a detailed roadmap for monitoring safety-related processes.

b. Business Benefits of an SMS. Development and implementation of an SMS can give the aviation service provider's management a structured set of tools to meet their legal responsibilities but they can also provide significant business benefits. The SMS incorporates internal evaluation and quality assurance concepts that can result in more structured management and continuous improvement of operational processes. The SMS outlined in this AC is designed to allow integration of safety efforts into the operator's business model and to integrate other systems such as quality, occupational safety, and environmental control systems that operators might already have in place or might be considering. Operators in other countries and in other industries who have integrated SMSs into their business models report that the added emphasis on process management and continuous improvement benefits them financially as well.

5. SMS PRINCIPLES.

a. Safety Management. Modern management and safety oversight practices are moving increasingly toward a systems approach that concentrates more on control of processes rather than efforts targeted toward extensive inspection and remedial actions on end products. One way of breaking down SMS concepts is to discuss briefly the three words that make it up: safety, management, and systems. Then we'll touch on another essential aspect of safety management; safety culture.

(1) Safety: Requirements Based on Risk Management. The objective of an SMS is to provide a structured management system to control risk in operations. Effective safety management must be based on characteristics of an operator's processes that affect safety.

Safety is defined in dictionaries in terms of absence of potential harm, an obviously impractical goal. However, risk, being described in terms of severity of consequences (how much harm) and likelihood (how likely we are of suffering harm) is a more tangible object of management. We can identify and analyze the factors that make us more or less likely to be involved in accidents of incidents as well as the relative severity of the outcomes. From here, we can use this knowledge to set system requirements and take steps to insure that they are met. Effective safety management is, therefore, risk management.

(2) Management: Safety Assurance Using Quality Management Techniques. In a recent set of working papers and guidance documents, the International Civil Aviation Organization (ICAO) emphasized that safety is a managerial process, shared by both the state (government regulators such as the FAA) and those who conduct aviation operations or produce products or services that support those operations.[1] This is compatible with the goals set forth for the FAA and industry in the Federal Aviation Act of 1958. The safety management process described in this AC starts with design and implementation of organizational processes and procedures to control risk in aviation operations. Once these controls are in place, quality management techniques can be used to provide a structured process for ensuring that they achieve their intended objectives and, where they fall short, to improve them. Safety management can, therefore, be thought of as quality management of safety related operational and support processes to achieve safety goals.

(3) Systems: Focusing on a Systems Approach. Systems can be described in terms of integrated networks of people and other resources performing activities that accomplish some mission or goal in a prescribed environment. Management of the system's activities involves planning, organizing, directing, and controlling these assets toward the organization's goals. Several important characteristics of systems and their underlying process are known as "process attributes" or "safety attributes.[2]" when they are applied to safety related operational and support processes. As in the previous discussion of quality, these process attributes must have safety requirements built in to their design if they are to result in desired safety outcomes. The attributes include:

(a) Responsibility and authority for accomplishment of required activities,

(b) Procedures to provide clear instructions for the members of the organization to follow,

(c) Controls which provide organizational and supervisory controls on the activities involved in processes to ensure they produce the correct outputs, and

(d) Measures of both the processes and their products.

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[1] ICAO Document 9734, Draft Safety Oversight Manual; ICAO Document 9859, Safety Management Manual, March 2006; and ICAO Working Paper from the ICAO Air Navigation Commission, Approval of Draft Report to Counsel on Amendment 30 to Annex 6, part 1.

[2] The six system characteristics, responsibility, authority, procedures, controls, process measures, and interfaces, are called "safety attributes" in the FAA's Air Transportation Oversight System (ATOS).

(e) An important aspect of systems management also is recognizing the important interrelationships or interfaces between individuals and organizations within the company as well as with contractors, vendors, customers, and other organizations with which the company does business.

b. Safety Culture: The Essential Human Component of Organizations. "An organization's culture consists of its values, beliefs, legends, rituals, mission goals, performance measures, and sense of responsibility to its employees, customers, and the community.[3]" The principles discussed above that make up the SMS functions will not achieve their goals unless the people that make up the organization function together in a manner that promotes safe operations. The organizational aspect that is related to safety is frequently called the "safety culture." The safety culture consists of psychological (how people think), behavioral (how people act), and organizational elements. The organizational elements are the things that are most under management control, the other two elements being outcomes of those efforts. For this reason, the SMS standard that is contained in Appendix 1 of this AC includes requirements for policies that will provide the framework for the SMS and requirements for organizational functions such as an effective employee safety reporting system and clear lines of communications both up and down the organizational chain regarding safety matters.

6. SYSTEM FUNCTIONS AND RELATIONSHIPS.

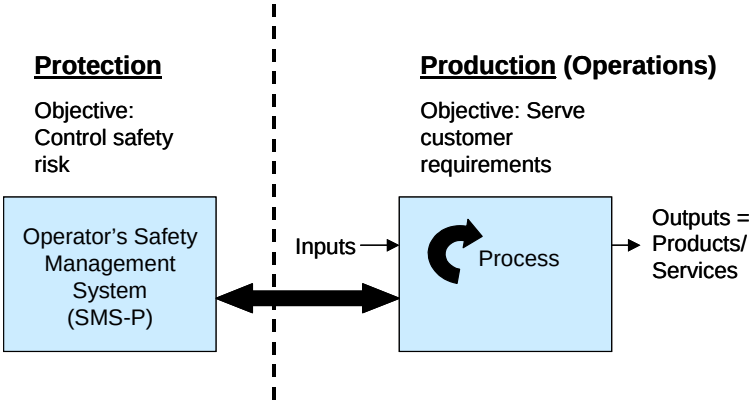
a. System Goals: Production and Protection. The global aviation system is really a "system of systems." Figure 1 depicts the relationship between the systems that are related to safety. The Figure depicts the relationships between the technical and management functions in the company that are related to providing customers with products or services and the functions that are related to controlling risk that is often a byproduct of the operations. The dichotomy between "production" and "protection" in the Figure, therefore, refers to the functions and requirements that are attendant to producing products or services (e.g. flight operations, flight training) and those that are involved in ensuring safety. As pointed out by Dr. James Reason, a prominent organizational safety researcher, these functions must be kept in harmony if the organization is to remain financially viable while controlling safety risk.[4]

> **NOTE: The depiction in Figure 1 refers to functional roles and not organizational structures. It is not meant to suggest that safety management is the sole responsibility of a "safety department" or "safety manager." In fact, the SMS standard stresses the role of those who manage the productive "line operational' processes in safety management.**

[3] Manuele, Fred A. On the Practice of Safety. John Wiley & Sons, 2003, Hoboken, NJ.

[4] Reason, Dr. James. Managing the Risk of Organizational Accidents. Ashgate Publishing Limited, 1997, Aldershot, United Kingdom.

FIGURE 1. SYSTEM RELATIONSHIPS



(1) Production in Aviation Systems: Conducting Operations. The production system that produces the product or service that is the mission of the aviation service provider's organization. For operators, these services usually involve provision of transportation services but may also include providing additional services to other companies such as maintenance and flight crew training. One of the first tasks in effective risk management and safety assurance is for both the operator and an oversight organization to have a thorough understanding of the configuration and structure of this system and its processes. A significant number of hazards and risk factors exist from improper design of these processes or a poor fit between the system and its operational environment. In these cases, hazards to operational safety may be poorly understood and, therefore, inadequately controlled.

(2) Protection in Aviation Systems: Controlling Risk. Safety risk is a byproduct of activities related to production. The aviation service provider's customers and employees are, therefore, the potential direct victims of the consequences of failures in the safety system. It is a primary responsibility of the aviation service provider to identify hazards and to control risk in the processes they manage and their operational environment. The aviation service provider is primarily responsible for safety management. The aviation service provider's SMS (denoted as the SMS-P to differentiate it from the FAA's safety oversight system, later referred to as the SMS-O) provides a formal management system for the operator's management to fulfill this obligation.

b. Safety Management Systems for Certificated Organizations. As aviation service providers develop SMSs, a natural interaction between the safety management efforts of the FAA and those of aviation service providers also develops. This relationship can leverage the efforts of both parties to provide a more effective, efficient, and proactive approach to meeting safety requirements while at the same time increasing the flexibility of companies to tailor their safety management efforts to their individual business models. There are distinct roles, responsibilities, and relationships (the "three Rs") for both regulators (FAA) and aviation service providers in the "system of systems" that is involved in management of safety.

(1) Responsibilities of Certificated Operators and Aviation Service Providers. Operators who hold out to provide services in common carriage to the public have a special responsibility to provide their customers with safe, reliable transportation. Title 49 of the United

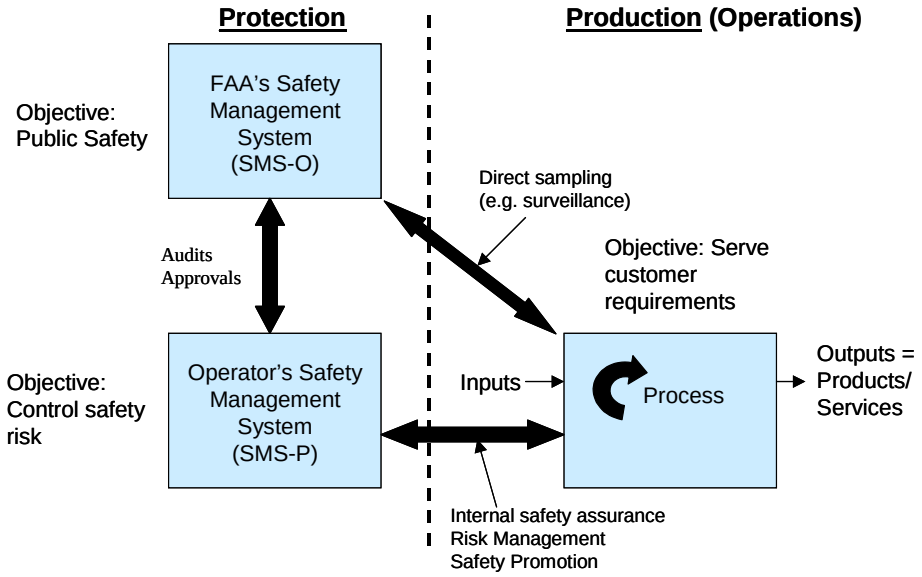
States Code, subtitle VII, chapter 447, section 44702 states, in part, that "When issuing a certificate under this chapter, the Administrator shall consider the duty of an air carrier to provide service with the highest possible degree of safety in the public interest and differences between air transportation and other air commerce…." This section of the public law makes management of safety a specific legal responsibility for air carrier management teams and, as such, is a fundamental principle of the FAA oversight doctrine. While this section applies specifically to air carriers, the FAA expects all certificated organizations to make safety a top priority and holds their managements accountable for doing so.

(2) Oversight Responsibilities of the FAA. United States Code Title 49 Subtitle VII Chapter 447 also prescribes roles and responsibilities of the FAA. The FAA is tasked with developing and implementing regulations and standards of other safety oversight activities that ensure operators apply those regulations and standards to the design and continuing operational safety of their organizations. These regulations and standards and the processes that apply them to certificate holders should be thought of as important safety risk controls, rather than just bureaucratic requirements.

(3) Oversight Systems. The other system on the "protection" side of the model in Figure 2 is the SMS-O, the system that is used by the regulator to provide oversight of the aviation service provider's operations. Traditional oversight of aviation service providers consists of activities such as certification, surveillance, investigation, and enforcement of regulations. The FAA is transitioning the traditional oversight process from a quality control approach with principal emphasis on surveillance of compliance with technical standards to a systems approach that stresses the systemic nature of aviation businesses and the larger system as a whole. While traditional oversight functions will continue to exist in future safety oversight systems, the primary means of safety oversight will shift more toward system safety methods and an emphasis on operator safety management. Moreover, the ability of the government to provide the resources that would be required to manage safety through intensive direct intervention in aviation service provider's activities is questionable at best.

(4) Relationships between Aviation Service Provider's SMS and Oversight. Figure 2 depicts the functional relationships between the productive processes in aviation service provider organizations, their safety management functions, and the functions of FAA oversight activities. On the "protection" side of the model depicted in Figure 2, two management systems exist: the aviation service provider's SMS (noted as SMS-P) and that of the oversight organization or regulator (noted as SMS-O).

FIGURE 2. SYSTEM RELATIONSHIPS. CERTIFICATED OPERATORS



(5) Voluntary Programs and the SMS. The FAA is seeking to increase the use of voluntary programs in the process of safety management, particularly use of the Aviation Safety Action Program (ASAP) and internal evaluation programs (IEP). Both of these programs have strong relationships to the functions of safety assurance and safety promotion in an SMS. Aviation service providers are encouraged to consider integrating these programs into a comprehensive approach to safety management.

c. Future Developments in Safety Management. A well-developed SMS and a strong relationship with the oversight system provide an excellent place from which to develop an integrated program between regulatory programs, voluntary programs, and the operator's own systems. The FAA Flight Standards Service is developing procedures to provide more effective interfaces in this process and to make both voluntary and regulatory programs more standardized and interoperable. These processes include improved, joint-use auditing tools and processes, procedures for information sharing and protection, and voluntary disclosure procedures. In the interim, certificated organizations should work closely with their certificate-holding district office (CHDO) or certificate management office (CMO) to build an SMS that will interface smoothly with regulatory oversight programs. For example, an SMS that incorporates the operator's continuing analysis and surveillance system (CASS — for certificated operators), an IEP, and an ASAP would allow the operator to derive the multiple benefits of these programs with a minimum of duplication. For operators that desire to implement Flight Operations Quality Assurance (FOQA) programs, these programs can also contribute to the safety assurance function.

7. THE SMS STANDARD: INTRODUCTION.

a. The Need for Safety Management Standards.

(1) Standardization. The FAA Associate Administrator for Aviation Safety (AVS) is interested in developing an integrated SMS in which business and governmental roles and relationships are well defined, requirements are based upon sound systems engineering and system safety principles, and both regulators and regulated industries participate in a unified safety effort. The SMS standard in appendix 1 of this AC provides functional requirements for an aviation safety SMS. It is similar in scope to internationally recognized standards for quality management, environmental protection, and occupational safety and health management.

(2) International Harmonization. ICAO, in a recent set of working papers, manuals, and proposals[5] for changes to key annexes to the ICAO Conventions, is revamping its standards and recommended practices to reflect a systems approach to safety management. This coincides with the FAA's move toward a systems approach for oversight over the past several years. Because of the many diverse relationships between organizations and the above stated global nature of the aviation system, it is critical that the functions of an SMS be standardized to the point that there is a common recognition of the meaning of SMS among all concerned, both domestically and internationally.

(3) Alignment with International Organization for Standardization (ISO) Standards. The SMS standard is written at the approximate scope and scale of the international standards for quality management (QMS) and management of environmental protection (EMS), ISO 9000-2000 and ISO 14001, respectively. The FAA also reviewed the British Standards Institute's standard for occupational health and safety management systems (OHSMS), which is based on ISO 14001. The clause structure of the aviation service provider SMS standard initially was developed to parallel ISO 14001, with the clauses then being arranged around the four building blocks discussed below under "The Four Pillars of Safety Management."

(4) Alignment with Other Industry Standards. The SMS standard was developed after an extensive review of documented SMS systems used by other countries around the world.[6] This review included literature reviews of regulations, policy documents, and advisory material, as well as interviews with both government and industry personnel who promulgated and used the systems. Existing management system standards from the International Standardization Organization (ISO) and the American National Standards Institute (ANSI) were reviewed cross-mapped.[7] The review also included consideration of third-party systems developed by user organizations such as the International Air Transport Association (IATA), the Medallion Foundation, and the International Business Aviation Council (IBAC)[8].

(5) Auditability. The SMS standard is designed to provide definitive functional requirements in a manner that can be audited by the organization's own personnel, regulators, or

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[5] Ibid. See footnote 1.

[6] The review included review of documents and interviews of government and industry personnel from Australia, Canada, New Zealand, and the United Kingdarom.

[7] A matrix showing the functional correlation between the SMS standard in Appendix 1 of this AC and existing standards for quality management, environmental control, and occupational safety and health management is included as Appendix 2.

[8] This preliminary literature review was conducted to compare content of the various programs and documents and did not assess any of the reviewed programs for completeness or assurance of regulatory compliance.

other third-party consultants. The language in the standard is, therefore, written in a requirements-oriented tone. To the maximum extent possible, each indexed statement defines a single requirement so that it can easily be used in audits of the system.

(6) Integration with Other Management Systems. While the SMS standard's stated scope is on product and service safety, the FAA recognizes that managers in real-world organizations may often, if not usually, be required to manage not only this aspect of safety, but also occupational safety and environmental protection, as well. Managers of these organizations typically are required to fit their activities into the framework of the organization's mission or commercial objectives and may operate under an integrated management system. The SMS standard therefore can be mapped to other existing standards covering these areas so that organizations may develop integrated management systems. Appendix 2 provides a cross-reference between the SMS standard presented in Appendix 1 and several other commonly used management standards.

b. Structure and Organization.

(1) Functional Orientation. The SMS Standard is written as a functional requirements document. It stresses "what" the organization must do rather than "how" it will be accomplished. The FAA feels that each of the functions detailed in the standard are essential for a comprehensive SMS. At the same time, the standard needs to be applicable to a wide variety of types and sizes of operators. Therefore, it is designed to allow operators to integrate safety management practices into their unique business models. Operators are not expected to configure their systems in the format of the standard or to duplicate existing programs that accomplish the same function. This was a further reason for using a similar scope, scale, and language to the ISO standards, which also are designed for broad application. The standard document contained in Appendix 1, therefore, attempts to strike a balance between flexibility of implementation and functional standardization of essential safety management processes.

(2) Four Pillars of Safety Management. The standard is organized around four basic building blocks of safety management. These four areas are essential for a safety-oriented management system, and derive from the SMS principles discussed earlier.

(a) Policy. All management systems must define policies, procedures, and organizational structures to accomplish their goals. Requirements for these elements are outlined in Appendix 1, par 4 which in turn provide the framework for SMS functional elements.

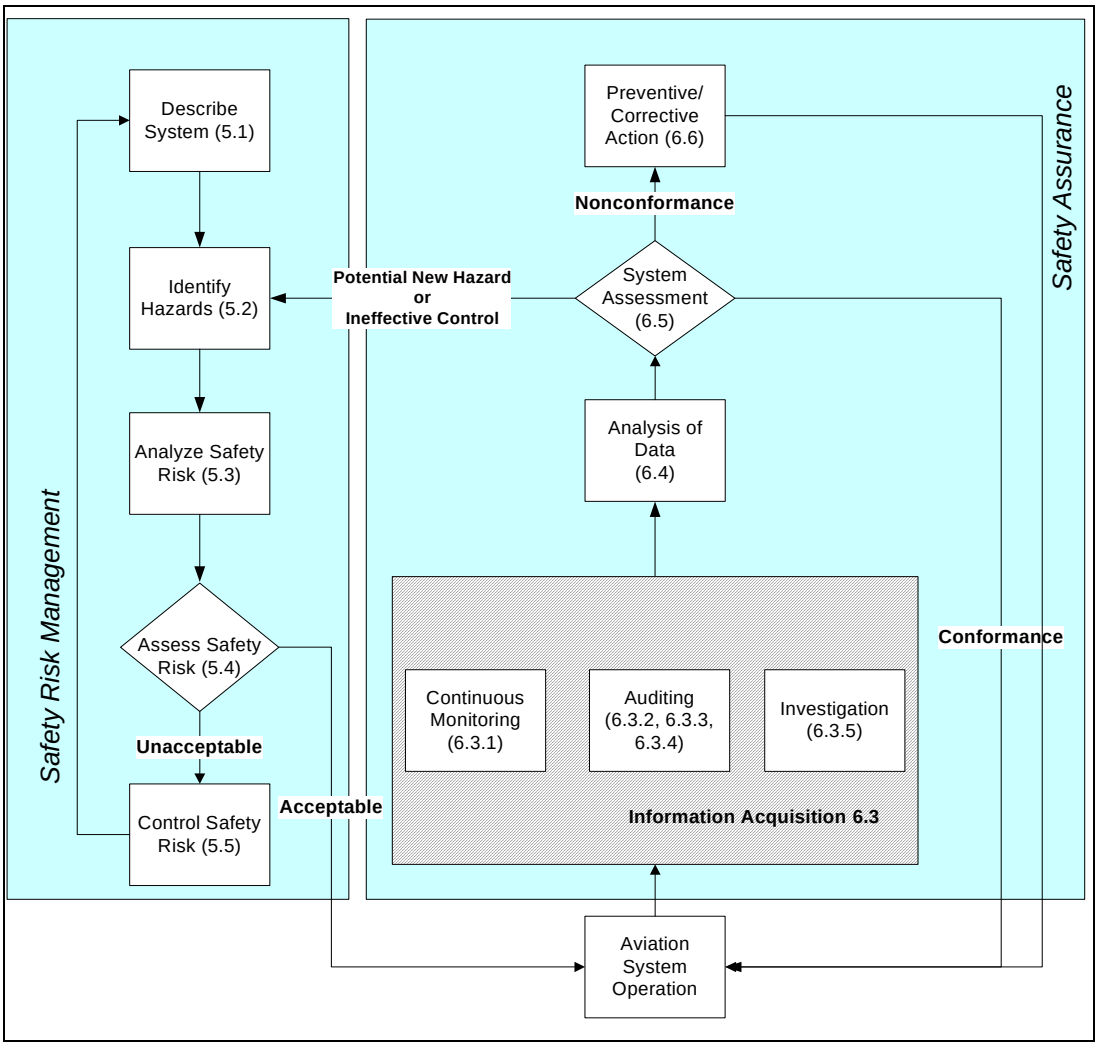
(b) Safety risk management. A formal system of hazard identification and safety risk management in Appendix 1, par. 5 is essential in controlling risk to acceptable levels. The safety risk management component of the SMS is based upon the system safety process model that is used in the system safety training course that is taught at the FAA Academy.

(c) Safety assurance. Once these controls are identified, the operator must ensure they are continuously practiced and continue to be effective in a changing environment. The safety assurance function in Appendix 1, par 6 provides for this using quality management concepts and processes.

(d) Safety promotion. Finally, the operator must promote safety as a core value with practices that support a sound safety culture. Appendix 1 par. 7 provides guidance for setting up these functions.

(3) Integration of Safety Risk Management and Safety Assurance. Figure 3 shows how the safety risk management and safety assurance processes are integrated in the SMS. The safety risk management process provides for initial identification of hazards and assessment of risk. Organizational risk controls are developed and, once they are determined to be capable of bringing the risk to an acceptable level, they are employed operationally. The safety assurance function takes over at this point to ensure that the risk controls are being practiced and they continue to achieve their intended objectives. This system also provides for assessment of the need for new controls because of changes in the operational environment.

FIGURE 3. SAFETY RISK MANAGEMENT AND SAFETY ASSURANCE PROCESSES[9]



[9] The numbers in the process blocks shown in Figure 3 refer to clause numbers in the SMS standard in Appendix 1 to this AC.

8. THE SMS STANDARD.

a. General Organization of the SMS Standard. The first part of the SMS functional requirements (SMS Standard) included as Appendix 1 of this AC follows the general organization of ISO 9000-2000 and ISO 14001. The first three clauses describe scope and applicability, references, and definitions. The following four clauses address each of the four pillars of SMS, as described previously in paragraph 7b(2).

b. Policy: Setting the Framework.

(1) Safety and Quality: Striking a Balance. As discussed above, the SMS standard uses quality management principles, but the requirements to be managed by the system are based on an objective assessment of safety risk, rather than customer satisfaction with products or other conventional commercial goals. However, management of process quality, with emphasis on those characteristics of those processes that affect safety, is an important aspect of safety management. The standard specifies that the aviation service provider should prescribe both quality and safety policies. The coverage of quality policies is limited in scope to quality in support of safety, although operators are encouraged to integrate their management systems as much as feasible. However, safety objectives should receive primacy where conflicts are identified.

(2) Roles, Responsibilities, and Relationships: The "Three Rs" of Safety Management. Figures 1 and 2 show the relationship between the productive processes of the aviation service provider as well as the joint protective processes of the regulator (FAA) in the form of an oversight system (SMS-O) and the aviation service provider's SMS (SMS-P). As before, it is important to recognize that the two aviation service provider systems shown (Protection and Production) are functional rather than departmental or organizational depictions. One of the principal roles of the oversight system (SMS-O) is to promulgate risk controls in the form of regulations, standards, and policies. It follows that regulatory compliance, in a manner that accomplishes the regulations' safety objectives, is also part of the aviation service provider's role in safety management.

(3) Importance of Executive Management Involvement. The standard specifies that top management is primarily responsible for safety management. Managements must plan, organize, direct, and control employees' activities and allocate resources to make safety controls effective. A key factor in both quality and safety management is top management's personal, material involvement in quality and safety activities. The standard also specifies that top management must further clearly delineate safety responsibilities throughout the organization. While it is true that top management must take overall responsibility for safe operations, it also is true that all members of the organization must know their responsibilities and be both empowered and involved with respect to safety.

(4) Procedures and Controls. Two key attributes of systems are procedures and controls. Policies must be translated into procedures in order for them to be applied and organizational controls must be in place to ensure that critical steps are accomplished as designed. Organizations must develop, document, and maintain procedures to carry out their safety policies and objectives. The standard also requires organizations to ensure that employees

understand their roles. Moreover, supervisory controls must be used to monitor the accomplishment of the procedures.

c. Safety Risk Management: Setting Requirements for Safety Management. The safety risk management process is used to examine the operational functions of the company and their operational environment to identify hazards and to analyze associated risk. The safety risk management process follows the same sequence of steps as the system safety process model that is used in the FAA's System Safety training course at the FAA Academy. These are also the same general steps that are used in operational risk management programs within several of the military services.

(1) Systems and Task Analysis. Safety risk management begins with system design. This is true whether the system in question is a physical system, such as an aircraft, or an organizational system such as an operator, maintenance or training establishment. These systems consist of the organizational structures, processes, and procedures, as well as the people, equipment, and facilities used to accomplish the organization's mission. The system or task descriptions should completely explain the interactions among the hardware, software, people, and environment that make up the system in sufficient detail to identify hazards and perform risk analyses. While systems should be documented, no particular format or is required. System documentation would normally include the operator's manual system,[10] checklists, organizational charts, and personnel position descriptions. A suggested breakdown of operational and support processes for air operators includes:

(a) Flight operations;

(b) Dispatch/flight following;

(c) Maintenance and inspection;

(d) Cabin safety;

(e) Ground handling and servicing;

(f) Cargo handling; and

(g) Training.

NOTE: Long and excessively detailed system or task descriptions are not necessary as long as they are sufficiently detailed to perform hazard and risk analyses. While sophisticated process development tools and methods are available, simple brainstorming sessions with managers, supervisors, and other employees are often most effective.

(2) Hazard Identification. Hazards in the system and its operating environment must be identified, documented, and controlled. It also requires that the analysis process used to

[10] While manuals are required only for certificated operators and agencies, all operators are encouraged to develop a manuals as a means of documenting their policies and procedures.

define hazards consider all components of the system, based on the system description described above. The key question to ask during analysis of the system and its operation is "what if?" As with system and task descriptions, judgment is required to determine the adequate level of detail. While identification of every conceivable hazard would be impractical, aviation service providers are expected to exercise due diligence in identifying significant and reasonably foreseeable hazards related to their operations.

(3) Risk Analysis and Assessment. The standard's risk analysis and risk assessment clauses use a conventional breakdown of risk by its two components: likelihood of occurrence of an injurious mishap and severity of the mishap related to an identified hazard, should it occur. A common tool for risk decision-making and acceptance is a risk matrix similar to those in the U.S. Military Standard (MIL STD 882) and the ICAO Safety Management Manual[11]. Figure 4 shows an example of one such matrix. Operators should develop a matrix that best represents their operational environment. Separate matrices with different risk acceptance criteria may also be developed for long-term versus short-term operations.

(4) Severity and Likelihood Criteria. The definitions and final construction of the matrix is left to the aviation service provider's organization to design. The definitions of each level of severity and likelihood will be defined in terms that are realistic for the operational environment. This ensures each organization's decision tools are relevant to their operations and operational environment, recognizing the extensive diversity in this area. An example of severity and likelihood definitions is shown in Table 1 below. Each operator's specific definitions for severity and likelihood may be qualitative but quantitative measures are preferable, where possible.

TABLE 1. SAMPLE SEVERITY AND LIKELIHOOD CRITERIA[12]

Severity of Consequences			**Likelihood of Occurrence**		
Severity Level	Definition	Value	Likelihood Level	Definition	Value
Catastrophic	Equipment destroyed, multiple deaths	5	Frequent	Likely to occur many times	5
Hazardous	Large reduction in safety margins, physical distress or a workload such that operators cannot be relied upon to perform their tasks accurately or completely. Serious injury or death to a number of people.	4	Occasional	Likely to occur sometimes	4

[11] Available at: http://www.icao.int/fsix

[12] Adapted from ICAO Safety Management Manual (SMM). ICAO Doc 9859. Available at: http://www.icao.int/fsix

Severity of Consequences			Likelihood of Occurrence		
	Major equipment damage.				
Severity Level	Definition	Value	Likelihood Level	Definition	Value
Major	Significant reduction in safety margins, reduction in the ability of operators to cope with adverse operating conditions as a result of an increase in workload, or as result of conditions impairing their efficiency. Serious incident. Injury to persons.	3	Remote	Unlikely, but possible to occur	3
Minor	Nuisance. Operating limitations. Use of emergency procedures. Minor incident.	2	Improbable	Very unlikely to occur	2
Negligible	Little consequence	1	Extremely Improbable	Almost inconceivable that the event will occur	1

(5) Risk Acceptance. In the development of its risk assessment criteria, aviation service providers are expected to develop risk acceptance procedures, including acceptance criteria and designation of authority and responsibility for risk management decision making. The acceptability of risk can be evaluated using a risk matrix such as the one illustrated in Figure 4. The example matrix shows three areas of acceptability. Risk matrices may be color coded; unacceptable (red), acceptable (green), and acceptable with mitigation (yellow).

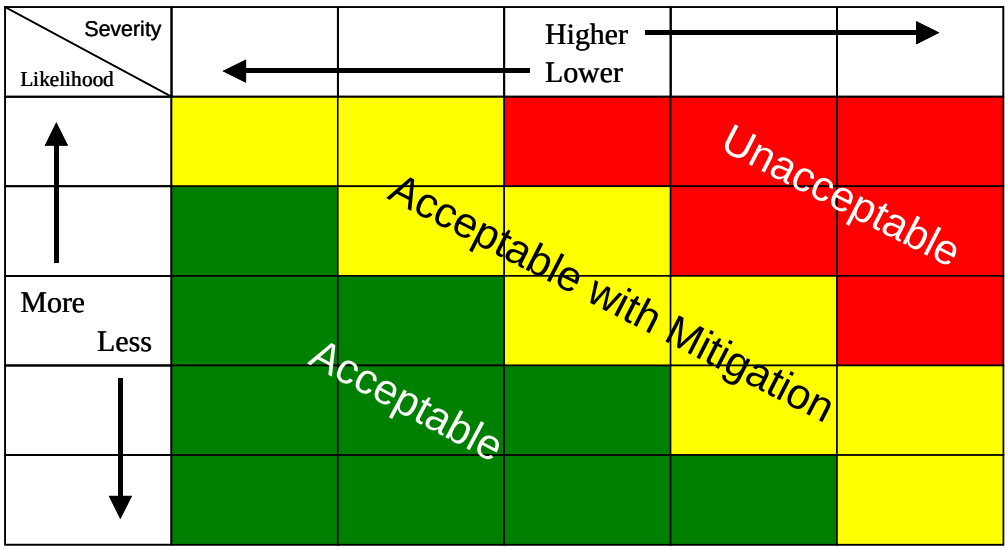
(a) Unacceptable (Red). Where combinations of severity and likelihood cause risk to fall into the red area, the risk would be assessed as unacceptable and further work would be required to design an intervention to eliminate that associated hazard or to control the factors that lead to higher risk likelihood or severity.

(b) Acceptable (Green). Where the assessed risk falls into the green area, it may be accepted without further action. The objective in risk management should always be to reduce

risk to as low as practicable regardless of whether or not the assessment shows that it can be accepted as is. This is a fundamental principle of continuous improvement.

(c) Acceptable with Mitigation (Yellow). Where the risk assessment falls into the yellow area, the risk may be accepted under defined conditions of mitigation. An example of this situation would be an assessment of the impact of a non-operational aircraft component for inclusion on a Minimum Equipment List. Defining an Operational ("O") or Maintenance ("M") procedure in the MEL would constitute a mitigating action that could make an otherwise unacceptable risk acceptable, as long as the defined procedure was implemented. These situations may also require continued special emphasis in the safety assurance function.

FIGURE 4. SAFETY RISK MATRIX



(6) Other Risk Assessment Tools for Flight and Operational Risk Management. Other tools can also be used for flight or operational risk assessment such as the Controlled Flight into Terrain (CFIT), Approach and Landing Accident Reduction (ALAR), operational control, and ground operations risk assessment tools available from the Flight Safety Foundation (http://www.flightsafety.org/technical_initiatives.html) or the Medallion Foundation (http://www.medallionfoundation.org).

(7) Causal Analysis. Risk analyses should concentrate not only on assigning levels of severity and likelihood but on determining why these particular levels were selected. This is often called "root cause analysis," and is the first step in developing effective controls to reduce risk to lower levels. Several structured software systems are available to perform root cause analysis. However, in many cases, simple brainstorming sessions among the company's pilots, mechanics, or dispatchers other experienced subject matter experts is the most effective and affordable method of finding ways to reduce risk. This also has the advantage of involving employees who will ultimately be required to implement the controls developed.

(8) Controlling Risk. After hazards and risk are fully understood though the preceding steps, risk controls must be designed and implemented. These may be additional or changed

procedures, new supervisory controls, addition of organizational, hardware, or software aids, changes to training, additional or modified equipment, changes to staffing arrangements, or any of a number of other system changes.

(9) Hierarchy of Controls. The process of selecting or designing controls should be approached in a structured manner. System safety technology and practice has provided a hierarchy or preferred order of control actions that range from most to least effective. Depending on the hazard under scrutiny and its complexity there may be more than one action or strategy that may be applied. Further, the controls may be applied at different times depending on the immediacy of the required action and the complexity of developing more effective controls. For example, it may be appropriate to post warnings while a more effective elimination of the hazard is developed. The hierarchy of controls is:

(a) Design the hazard out – modify the system (this includes hardware/software systems involving physical hazards as well as organizational systems).

(b) Physical guards or barriers – reduce exposure to the hazard or reduce the severity of consequences.

(c) Warnings, advisories, or signals of the hazard.

(d) Procedural changes to avoid the hazard or reduce likelihood or severity of associated risk

(e) Training to avoid the hazard or reduce the likelihood of an associated risk.

(10) Residual and Substitute Risk. It is seldom possible to entirely eliminate risk, even when highly effective controls are used. After these controls are designed but before the system is placed back on line, an assessment must be made of whether the controls are likely to be effective and/or if they introduce new hazards to the system. The latter condition is referred to as "substitute risk," a situation where "the cure is worse than the disease." The loop seen in Figure 3 back to the top of the diagram depicts the use of the preceding systems analysis, hazard identification, risk analysis, and risk assessment processes to determine if the modified system is acceptable.

(11) System Operation. When the controls are acceptable, the system is placed into operation. The next process, safety assurance, uses auditing, analysis, and review systems that are familiar from similar quality management systems. These processes are used to monitor the risk controls to ensure they continue to be implemented as designed and continue to be effective in a changing operational environment.

d. Safety Assurance: Managing the Requirements. The safety assurance function applies the processes of quality assurance and internal evaluation to the process of making sure that risk controls, once designed, continue to conform to their requirements and that they continue to be effective in maintaining risk within acceptable levels. These assurance and evaluation functions also provide a basis for continuous improvement.

(1) Relationship between Safety Risk Management, Safety Assurance, and Internal Evaluation. Quality assurance processes concentrate on proving, through collection and analysis of objective evidence, that process requirements have been met. In an SMS, the system's requirements are based on assessment of risk in the organization's operation or in the products that it produces, as discussed above. Quality assurance techniques, including internal auditing and evaluation, can be used to determine if risk controls that are designed into the operator's processes are being practiced and that they perform as designed. The process is, therefore, appropriately termed "safety assurance." If an operator already has an IEP, it should be reviewed to ensure that it conforms to the SMS safety assurance standards.[13]

NOTE: the safety assurance function does not need to be extensive or complex to be effective. Smaller organizations may find available tools such as the Internal Evaluation Program Audit tools produced by the Medallion Foundation (http://www.medallionfoundation.org) to be a good foundation for their organization's safety assurance processes.

(2) Role of Other Management Systems. As discussed above, safety assurance uses many of the same practices as those used in quality management systems (QMS). In an SMS however the requirements being managed relate to ensuring risk controls, once designed and put into place, perform in a way that continues to meet their safety objectives. While operators may find it beneficial to integrate their management systems for these other areas, such as quality, employee health and safety, or environmental protection with the SMS, it is beyond the scope of the safety management standard to address these areas directly. Appendix 2 to this AC contains a table of cross-references between ISO standards and other recognized standards for quality (ISO 9000:2000), environmental protection (ISO 14001), and employee health and safety management (BSI OHSAS 18001). These are provided for convenience for organizations that desire to develop integrated management systems or that may already have existing systems in one or more of these areas.

(3) Information for Decisionmaking. Information for safety assurance comes from a variety of sources, including formal program auditing and evaluation, investigations of safety-related events, and continuous process monitoring of day-to-day activities and inputs from employees through employee reporting systems. While each of these types of information sources exist to some degree in every organization, the standard formalizes requirements for each. Specifications for these and other related safety assurance processes are left at a functional level, allowing individual organizations to tailor them to the scope and scale appropriate for their size and type of organization.

[13] The safety assurance functions in the SMS standard contained in Appendix 1 were derived almost directly from ISO 9000-2000, the international quality management standard and the IEP development guidance in AC 120-59A.

(4) Internal Audits by Operating Departments. The primary responsibility for safety management rests with those who "own" the operator's technical processes. It is here where hazards are most directly encountered, where deficiencies in processes contribute to risk, and where direct supervisory control and resource allocation can mitigate the risk to acceptable levels. The standard specifies a responsibility for internal auditing of the operator's productive processes (the Production/Operation side of Figures 1 and 2). As with other requirements, the standard's auditing requirements are left at a functional level, allowing for a broad range of complexity, commensurate with the complexity of the organization.

(a) Line Management Responsibilities. Line managers of operational departments have the direct responsibility for quality control and for ensuring that the processes in their areas of responsibility function as designed. Moreover, line organizations are the domain technical experts in any organization and thus the most knowledgeable about the technical processes involved. Line managers of the operational departments should be given the responsibility for monitoring these processes and periodically assessing the status of risk controls though an internal auditing and evaluation program.

(b) Audit Programs and Tools. In order to promote system integration and a minimum of duplication, operators may want to consider using available technical system audit tools such as those provided by the Air Transportation Oversight System (ATOS)[14] or third party tools such as those in the IATA Operational Safety Audit (IOSA). This can be particularly advantageous if the operator is already involved with using these programs.

(5) Internal Evaluation. This function involves evaluation of the technical processes of the operator as well as the SMS-specific functions. Audits conducted for the purpose of this requirement must be conducted by persons or organizations that are functionally independent of the technical process being evaluated. A specialist safety or quality assurance department or another sub-organization as directed by top management may accomplish it. The internal evaluation function also requires auditing and evaluation of the safety management functions, policymaking, safety risk management, safety assurance, and safety promotion. These audits provide the management officials designated responsibility for the SMS to inventory the processes of the SMS itself.

NOTE: In very small organizations, the top management may elect to conduct the internal evaluation function themselves, in conjunction with the management review function.

(6) Integration of Regulatory and Voluntary Programs. The provisions of the SMS standard are not intended to duplicate the functions of required CASS (required for operators under part 121 or part 135 of Title 14 of the Code of Federal Regulations) (14 CFR) or IEPs. In fact, the FAA encourages an integrated approach where these programs are all part of a comprehensive SMS.

(7) External Audits. External audits of the SMS may be conducted by the regulator (FAA), code-share partners, customer organizations, or other third parties selected by the

[14] Available at: http://www.faa.gov/safety/programs_initiatives/oversight/atos/library/data_collection

operator. These audits not only provide a strong interface with the oversight system (SMS-O) but also a secondary assurance system. Organizations may elect to have third-party audits of their SMS from organizations such as the IATA or other consultant organizations.

(8) Analysis and Assessment. Audits and other information-gathering activities are useful to management only if the information is distilled into a meaningful form and conclusions are drawn to form a bottom line. Recall that the primary purpose of the safety assurance process is to assess the continued effectiveness of risk controls put into place by the safety risk management process. Where significant deviations to existing controls are discovered, the standard requires a structured, documented process for preventive and corrective action to place the controls back on track.

(9) Corrective Action and Followup. The safety assurance process should include procedures that ensure that corrective actions are developed in response to findings of audits and evaluations and to verify their timely and effective implementation. Organizational responsibility for the development and implementation of corrective actions should reside with the operational departments cited in audit and evaluation findings. If new hazards are discovered, the safety risk management process should be employed to determine if new risk controls should be developed.

(10) Monitoring the Environment. As part of the safety assurance function, the analysis and assessment functions must alert the organization to significant changes in the operating environment, possibly indicating a need for system change to maintain effective risk control. When this occurs, the results of the assessment start the safety risk management process, as depicted in Figure 3.

e. Safety Promotion: Supporting the Culture. An organizational safety effort cannot succeed by mandate or strictly though a mechanistic implementation of policy. As in the case of attitudes where individual people are concerned, organizational cultures set the tone that predisposes the organization's behavior. An organization's culture consists of the values, beliefs, mission, goals, and sense of responsibility held by the organization's members. The culture fills in the blank spaces in the organization's policies, procedures, and processes and provides a sense of purpose to safety efforts.

(1) Safety Cultures. Cultures consist of psychological (how people think and feel), behavioral (how people and groups act and perform) and structural (the programs, procedures, and organization of the enterprise) elements. Many of the processes specified in the policy, risk management, and assurance components of the SMS provide the framework for the structural element. However, the organization must also set in place processes that allow for communication among employees and with the organization's management. The aviation service provider must make every effort to communicate its goals and objectives, as well as the current status of the organization's activities and significant events. Likewise, the aviation service provider must supply a means of upward communication in an environment of openness.

(2) Communication: A Two Way Street. Dr. James Reason, among other current organizational system safety theorists, stresses the need for a "reporting culture" as an important aspect of safety culture. The organization must do what it can to cultivate the willingness of its members to contribute to the organization's knowledge base. Dr. Reason further stresses the

need for a "just culture," where employees have the confidence that, while they will be held accountable for their actions, the organization will treat them fairly.[15] The standard specifies that the aviation service provider must provide for a means of employee communication that allows for timely submission of reports on safety deficiencies without fear of reprisal. Many certificated operators already have invested in ASAP. ASAP is a collaborative, reporting, analysis, and problem solving effort among the FAA, operators, and employee unions. This program is another example of a voluntary program that could be integrated into the SMS, having a strong potential to contribute to the safety assurance and safety promotion.

(3) Organizational Learning. Another of Dr. Reason's principles of organizational safety culture is that of a "learning culture."[16] The information in reports, audits, investigation, and other data sources does no good if the organization does not learn from it. The standard also requires a means of analysis of this information and a linkage to the safety assurance process. The standard requires an analysis process, a preventive/corrective action process, and a path to the safety risk management process for the development of new safety controls, as environments change and new hazards are identified. It further requires that the organization provide training and information about risk controls and lessons learned.

9. CONTACT. For additional information or suggestions, please contact AFS-800 at (202) 267-8212, or AFS-900 at (703) 661-0526.

ORIGINAL SIGNED BY
John M. Allen (for)

James J. Ballough
Director, Flight Standards Service

[15] Reason. Managing the Risks of Organizational Accidents.

[16] Ibid.

APPENDIX 1. AIR OPERATOR SAFETY MANAGEMENT SYSTEM (SMS-P) STANDARD: FUNCTIONAL REQUIREMENTS

PURPOSE OF THIS APPENDIX. To provide a uniform standard for SMS development by aviation service providers.

1. Scope and Applicability

A) This Standard describes the requirements for a product/service provider's Safety Management System (SMS-P) in the air transportation system.

1) This standard is intended to address aviation safety related operational and support processes and activities rather than occupational safety, environmental protection, or customer service quality.

2) The requirements of this standard apply to Safety Management Systems developed and used by organizations that provide products and/or services in the air transportation system.

3) Operators and service providers are responsible for the safety of services or products contracted to or purchased from other organizations.

B) This document establishes the minimum acceptable requirements; oversight entities can establish more stringent requirements.

2. References

This Standard is in accordance with the following documents:

- Annex 6 to the Convention on International Civil Aviation, *Operation of Aircraft*
- International Civil Aviation Organization (ICAO) Document 9859, *ICAO Safety Management Manual*
- ICAO Document 9734, *Safety Oversight Manual*

3. Definitions

Accident – an unplanned event or series of events that results in death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Analysis – the process of identifying a question or issue to be addressed, modeling the issue, investigating model results, interpreting the results, and possibly making a recommendation. Analysis typically involves using scientific or mathematical methods for evaluation.

Assessment – process of measuring or judging the value or level of something.

Audit – scheduled, formal reviews and verifications to evaluate compliance with policy, standards, and/or contractual requirements. The starting point for an audit is the management and operations of the organization, and it moves outward to the organization's activities and products/services.

Internal audit – an audit conducted by, or on behalf of, the organization being audited.

External audit – an audit conducted by an entity outside of the organization being audited.

Aviation system – the functional operation/production system used by the service provider to produce the product/service (see Figure 1).

Complete – nothing has been omitted and the attributes stated are essential and appropriate to the level of detail.

Continuous monitoring – uninterrupted watchfulness over the system.

Corrective action – action to eliminate or mitigate the cause or reduce the effects of a detected nonconformity or other undesirable situation.

Correct – accurately reflects the item with an absence of ambiguity or error in its attributes.

Documentation – information or meaningful data and its supporting medium (e.g., paper, electronic, etc.). In this context it is distinct from records because it is the written description of policies, processes, procedures, objectives, requirements, authorities, responsibilities, or work instructions.

Evaluation – [ref. AC 120-59A] a functionally independent review of company policies, procedures, and systems. If accomplished by the company itself, the evaluation should be done by an element of the company other than the one performing the function being evaluated. The evaluation process builds on the concepts of auditing and inspection. An evaluation is an anticipatory process, and is designed to identify and correct potential findings before they occur. An evaluation is synonymous with the term systems audit.

Hazard – any existing or potential condition that can lead to injury, illness, or death to people; damage to or loss of a system, equipment, or property; or damage to the environment. A hazard is a condition that is a prerequisite to an accident or incident.

Incident – a near miss episode with minor consequences that could have resulted in greater loss. An unplanned event that could have resulted in an accident, or did result in minor damage, and indicates the existence of, though may not define, a hazard or hazardous condition.

Lessons learned – knowledge or understanding gained by experience, which may be positive, such as a successful test or mission, or negative, such as a mishap or failure. Lessons learned should be developed from information obtained from within, as well as outside of, the organization and/or industry.

Likelihood – the estimated probability or frequency, in quantitative or qualitative terms, of an occurrence related to the hazard.

Line management – management structure that operates the aviation system.

Nonconformity – non fulfillment of a requirement (ref. ISO 9000). This includes but is not limited to noncompliance with Federal regulations. It also includes company requirements, requirements of operator developed risk controls or operator specified policies and procedures.

Operational life cycle – period of time spanning from implementation of a product/service until it is no longer in use.

Oversight – a function that ensures the effective promulgation and implementation of the safety-related standards, requirements, regulations, and associated procedures. Safety oversight also ensures that the acceptable level of safety risk is not exceeded in the air transportation system. Safety oversight in the context of the safety management system will be conducted via oversight's safety management system (SMS-O).

Preventive action – action to eliminate or mitigate the cause or reduce the effects of a potential nonconformity or other undesirable situation.

Procedure – specified way to carry out an activity or a process.

Process – set of interrelated or interacting activities which transforms inputs into outputs.

Product/service – anything that might satisfy a want or need, which is offered in, or can be purchased in, the air transportation system. In this context, administrative or licensing fees paid to the government do not constitute a purchase.

Product/service provider – any entity that offers or sells a product/service to satisfy a want or need in the air transportation system. In this context, administrative or licensing fees paid to the government do not constitute a purchase. Examples of product/service providers include: aircraft and aircraft parts manufacturers; aircraft operators; maintainers of aircraft, avionics, and air traffic control equipment; educators in the air transportation system; etc. (Note: any entity that is a direct consumer of air navigation services and or operates in the U.S. airspace is included in this classification; examples include: general aviation, military aviation, and public use aircraft operators.)

Records – evidence of results achieved or activities performed. In this context it is distinct from documentation because records are the documentation of SMS outputs.

Residual safety risk – the remaining safety risk that exists after all control techniques have been implemented or exhausted, and all controls have been verified. Only verified controls can be used for the assessment of residual safety risk.

Risk – The composite of predicted severity and likelihood of the potential effect of a hazard in the worst credible system state.

Risk Control – refers to steps taken to eliminate hazards of to mitigate their effects by reducing severity and/or likelihood of risk associated with those hazards.

Safety assurance – SMS process management functions that systematically provide confidence that organizational products/services meet or exceed safety requirements.

Safety culture – the product of individual and group values, attitudes, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, the organization's management of safety. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures.

Safety Management System (SMS) – the formal, top-down business-like approach to managing safety risk. It includes systematic procedures, practices, and policies for the management of safety (as described in this document it includes safety risk management, safety policy, safety assurance, and safety promotion).

Product/Service Provider Safety Management System (SMS-P) – the SMS owned and operated by a product/service provider.

Oversight Safety Management System (SMS-O) – the SMS owned and operated by an oversight entity.

Safety objectives.[17]– something sought or aimed for, related to safety.

NOTE 1: Safety objectives are generally based on the organization's safety policy.

NOTE 2: Safety objectives are generally specified for relevant functions and levels in the organization.

Safety planning[18] – part of safety management focused on setting safety objectives and specifying necessary operational processes and related resources to fulfill the quality objectives.

Safety risk – the composite of predicted severity and likelihood of the potential effect of a hazard.

Safety risk control – anything that reduces or mitigates the safety risk of a hazard. Safety risk controls must be written in requirements language, measurable, and monitored to ensure effectiveness.

Safety risk management (SRM) – a formal process within the SMS composed of describing the system, identifying the hazards, assessing the risk, analyzing the risk, and controlling the risk. The SRM process is embedded in the processes used to provide the product/service; it is not a separate/distinct process.

Safety promotion – a combination of safety culture, training, and data sharing activities that support the implementation and operation of an SMS in an organization

Severity – the consequence or impact of a hazard in terms of degree of loss or harm.

Substitute risk – risk unintentionally created as a consequence of safety risk control(s).

System – an integrated set of constituent elements that are combined in an operational or support environment to accomplish a defined objective. These elements include people, hardware, software, firmware, information, procedures, facilities, services, and other support facets.

Top Management – (ref. ISO 9000-2000 definition 3.2.7) the person or group of people who directs and controls an organization.

4. Policy

4.1. General Requirements

A) Safety management shall be included in the complete scope of the operator's systems including:

[17] Adapted from definition 3.2.5 in ISO 9000-2000 for "quality objectives."

[18] Adapted from definition 3.2.9 in ISO 9000-2000 for "quality planning."

1) flight operations;
2) dispatch/flight following;
3) maintenance and inspection;
4) cabin safety;
5) ground handling and servicing;
6) cargo handling; and
7) training.

B) SMS processes shall be:

1) documented;
2) monitored;
3) measured; and
4) analyzed.

C) SMS outputs shall be:

1) recorded;
2) monitored;
3) measured; and
4) analyzed.

D) The organization shall promote the growth of a positive safety culture (described in Sections 4.2 and 7.1).

4.2. Safety Policy

A) Top management shall define the organization's safety policy.

B) The safety policy shall:

1) include a commitment to implement an SMS;
2) include a commitment to continual improvement in the level of safety;
3) include a commitment to the management of safety risk;
4) include a commitment to comply with applicable regulatory requirements;
5) include a commitment to encourage employees to report safety issues without reprisal;
6) establish clear standards for acceptable behavior;
7) provide management guidance for setting safety objectives;
8) provide management guidance for reviewing safety objectives;
9) be documented;
10) be communicated to all employees and responsible parties;

11) be reviewed periodically to ensure it remains relevant and appropriate to the organization; and

12) identify responsibility of management and employees with respect to safety performance.

4.3. Quality Policy

Top management shall ensure that the organization's quality policy is consistent with the SMS.

4.4. Safety Planning

The organization shall establish and maintain a safety management plan to meet the safety objectives described in its safety policy.

4.5. Organizational Structure and Responsibilities

A) Top management shall have the ultimate responsibility for the SMS.

B) Top management shall provide resources essential to implement and maintain the SMS.

C) Top management shall appoint a member of management who, irrespective of other responsibilities, shall have responsibilities and authority that includes:

1) ensuring that process needed for the SMS are established, implemented and maintained

2) reporting to top management on the performance of the SMS and the need for improvement, and

3) ensuring the promotion of awareness of safety requirements throughout the organization.

D) Aviation safety-related positions, responsibilities, and authorities shall be:

1) defined;

2) documented; and

3) communicated throughout the organization.

4.6. Compliance with Legal and Other Requirements

A) The SMS shall incorporate a means of compliance with safety-related legal and regulatory requirements.

B) The organization shall establish and maintain a procedure to identify to current safety-related legal and regulatory requirements applicable to the SMS.

4.7. Procedures and Controls

A) The organization shall establish and maintain procedures with measurable criteria to accomplish the objectives of the safety policy[19].

B) The organization shall establish and maintain process controls to ensure procedures are followed for safety-related operations and activities.

4.8. Emergency Preparedness and Response

The organization shall establish procedures to:

1) identify the potential for accidents and incidents;
2) coordinate and plan the organization's response to accidents and incidents; and
3) execute periodic exercises of the organization's response.

4.9. Documentation and Records Management

A) General.

The organization shall establish and maintain information, in paper or electronic form, to describe:

1) safety policies;
2) safety objectives;
3) SMS requirements;
4) safety-related procedures and processes;
5) responsibilities and authorities for safety-related procedures and processes;
6) interaction/interfaces between safety-related procedures and processes; and
7) SMS outputs.

B) Documentation Management.

1) Documentation shall be:

a) legible;

b) dated (with dates of revisions);

c) readily identifiable;

d) maintained in an orderly manner; and

e) retained for a specified period as determined by the organization (and approved by the oversight organization).

2) The organization shall establish and maintain procedures for controlling all documents required by this Standard to ensure that:

[19] Measures are not expected for each procedural step. However, measures and criteria should be of sufficient depth and level of detail to ascertain and track accomplishment of objectives. Criteria and measures can be expressed in either quantitative or qualitative terms.

a) they can be located;

b) they are periodically:

(1) reviewed,

(2) revised as necessary, and

(3) approved for adequacy by authorized personnel;

c) the current versions of relevant documents are available at all locations where operations essential to the effective functioning of the SMS are performed; and

d) obsolete documents are promptly removed from all points of use or otherwise assured against unintended use.

C) Records Management.

1) For SMS records, the organization shall establish and maintain procedures for their:

a) identification;

b) maintenance; and

c) disposition.

2) SMS records shall be:

a) legible;

b) identifiable; and

c) traceable to the activity involved.

3) SMS records shall be maintained in such a way that they are:

a) readily retrievable; and

b) protected against:

(1) damage,

(2) deterioration, or

(3) loss.

4) Record retention times shall be documented.

5. Safety Risk Management

A) SRM shall, at a minimum, include the following processes:

1) system and task analysis;

2) identify hazards;

3) analyze safety risk;

4) assess safety risk; and

5) control safety risk.

B) The SRM process shall be applied to:

1) initial designs of systems, organizations, and/or products;

2) the development of operational procedures;

3) hazards that are identified in the safety assurance functions (described in Section 6); and

4) planned changes to the operational processes to identify hazards associated with those changes.

C) The organization shall establish feedback loops between assurance functions described in Section 6 to evaluate the effectiveness of safety risk controls.

D) The organization shall define acceptable and unacceptable levels of safety risk (or safety risk objectives).

1) Descriptions shall be established for:

a) severity levels, and

b) likelihood levels.

2) The organization shall define levels of management that can make safety risk acceptance decisions.

3) The organization shall define acceptable risk for hazards that will exist in the short-term while safety risk control/mitigation plans are developed and executed.

E) The following shall not be implemented until the safety risk of each identified hazard is determined to be acceptable in:

1) new system designs;

2) changes to existing system designs;

3) new operations/procedures; and

4) modified operations/procedures.

F) The SRM process shall not preclude the organization from taking interim immediate action to mitigate existing safety risk.

5.1. System and Task Analysis

A) System and task descriptions shall be developed to the level of detail necessary to identify hazards.

B) System and task analyses should consider the following:

1) the system's interactions with other systems in the air transportation system (e.g. airports, air traffic control);

2) the system's functions for each area listed in para 4.1 A);

3) employee tasks required to accomplish the functions in 5.1 B) 2);

4) required human factors considerations of the system (e.g. cognitive, ergonomic, environmental, occupational health and safety) for:

a) operations, and

b) maintenance;

5) hardware components of the system;

6) software components of the system;

7) related procedures that define guidance for the operation and use of the system;

8) ambient environment;

9) operational environment;

10) maintenance environment;

11) contracted and purchased products and services;

12) the interactions between items in Section 5.1.B., 2 - 10 above; and

13) any assumptions made about:

a) the system,

b) system interactions, and

c) existing safety risk controls.

5.2. Identify Hazards

A) Hazards shall be:

1) identified for the entire scope of the system that is being evaluated as defined in the system description[20]; and

2) documented.

B) Hazard information shall be:

1) tracked, and

2) managed through the entire SRM process.

5.3. Analyze Safety Risk

The safety risk analysis process shall include:

1) existing safety risk controls;

2) triggering mechanisms; and;

3) safety risk of reasonably likely outcomes from the existence of a hazard, to include estimation of the:

a) likelihood; and

b) severity.

[20] While it is recognized that identification of every conceivable hazard is impractical, operators are expected to exercise due diligence in identifying and controlling significant and reasonably foreseeable hazards related to their operations.

5.4. Assess Safety Risk

A) Each hazard shall be assessed for its safety risk acceptability using the safety risk objectives described in Section 5D.

B) The organization shall define levels of management that can make safety risk acceptance decisions.

5.5. Control Safety Risk

A) Safety control/mitigation plans shall be defined for each hazard with unacceptable risk.

B) Safety risk controls shall be:

1) clearly described;
2) evaluated to ensure that the requirements have been met;
3) ready to be used in the operational environment for which they are intended; and
4) documented.

C) Substitute risk shall be evaluated in the creation of safety risk controls/mitigations.

6. Safety Assurance and Internal Evaluation

Figure 3 illustrates how Safety Assurance functions (described in Sections 6.2 – 6.6) are linked to the SRM process (described in Section 5).

6.1. General Requirements

The organization shall monitor heir systems and operations to:

1) identify new hazards;
2) measure the effectiveness of safety risk controls; and
3) ensure compliance with regulatory requirements.

6.2. System Description

The safety assurance function shall be based upon a comprehensive system description as described in Section 5.1.

6.3. Information Acquisition

The organization shall collect the data necessary to demonstrate the effectiveness of the organization's:

1) Operational processes; and
2) the SMS.

6.3.1 Continuous Monitoring

A) The organization shall monitor operational data (e.g., duty logs, crew reports, work cards, process sheets, or reports from the employee safety feedback system specified in Section 7.1.5 to:

1) assess conformity with safety risk controls (described in Section 5);
2) measure the effectiveness of safety risk controls (described in Section 5);
3) assess system performance; and
4) identify hazards.

B) The organization shall monitor products and services received from subcontractors.

6.3.2 Internal Audits by Operational Departments

A) Line management of operational departments shall ensure that regular internal audits of safety-related functions of the organization's operational processes (production system) are conducted. This obligation shall extend to any subcontractors that they may use to accomplish those functions.

B) Line management shall ensure that regular audits are conducted to:

1) determine conformity with safety risk controls; and
2) assess performance of safety risk controls.

C) Planning of the audit program shall take into account:

1) safety significance of the processes to be audited; and
2) the results of previous audits.

D) The audit program shall include:

1) definition of the audit:
   a) criteria,
   b) scope,
   c) frequency, and
   d) methods;
2) the processes used to select the auditors;
3) the requirement that individuals shall not audit their own work;
4) documented procedures, which include:
   a) the responsibilities; and
   b) requirements for:
      (1) planning audits,
      (2) conducting audits,
      (3) reporting results, and

(4) maintaining records; and

5) audits of contractors and vendors.

6.3.3 Internal Evaluation

A) The organization shall conduct internal evaluations of the operational processes and the SMS at planned intervals to determine that the SMS conforms to requirements.

B) Planning of the evaluation program shall take into account:

1) safety significance of processes to be audited; and

2) the results of previous audits.

C) The evaluation program shall include:

1) definition of the evaluation:

a) criteria;

b) scope;

c) frequency; and

d) methods;

2) the processes used to select the auditors;

3) the requirement that auditors shall not audit their own work;

4) documented procedures, which include:

a) the responsibilities, and

b) requirements for:

(1) planning audits,

(2) conducting audits,

(3) reporting results,

(4) and maintaining records; and

5) audits of contractors and vendors.

D) The program shall be under the direction of the management official described in Section 4.5.

E) The program shall include an evaluation of the program required described in Section 6.3.2.

F) The person or organization performing evaluations of operational departments must be functionally independent of the department being evaluated.

6.3.4 External Auditing of the SMS

A) The organization shall include the results of oversight organization audits in the analyses conducted as described in Section 6.4.

6.3.5 Investigation

A) The organization shall collect data on:

1) incidents, and

2) accidents.

B) The organization shall establish procedures to:

1) investigate accidents;

2) investigate incidents; and

3) investigate instances of potential regulatory non-compliance.

6.3.6 Employee Reporting and Feedback System.

A) The organization shall establish and maintain a confidential employee safety reporting and feedback system as in Section 7.1.5).

B) Employees shall be encouraged to use the safety reporting and feedback system without reprisal as in Section 4.2 B) 5).

C) Data from the safety reporting and feedback system shall be monitored to identify emerging hazards.

D) Data collected in the safety reporting and feedback system shall be included in analyses described in Section 6.4.

6.4. Analysis of Data

A) The organization shall analyze data the data described in Section 6.3 to demonstrate the effectiveness of:

1) risk controls in the organization's operational processes, and

2) the SMS.

B) Through data analysis, the organization shall evaluate where improvements can be made to the organization's:

1) operational processes, and

2) SMS.

6.5. System Assessment

A) The organization shall assess the performance of:

1) safety-related functions of operational processes against their requirements, and

2) the SMS against its requirements.

B) System assessments shall result in a finding of:

1) conformity with existing safety risk control(s)/ SMS requirement(s) (including regulatory requirements);

2) nonconformity with existing safety risk control(s)/ SMS requirement(s) (including regulatory requirements); and

3) new hazard(s) found.

C) The SRM process will be utilized if the assessment indicates:

1) the identification of new hazards; or

2) the need for system changes.

D) The organization shall maintain records of assessments in accordance with the requirements of Section 4.9.

6.6. Preventive/Corrective Action

A) The organization shall develop, prioritize, and implement, as appropriate:

1) corrective actions for identified nonconformities with risk controls; and

2) preventive actions for identified potential nonconformities with risk controls actions.

B) Safety lessons learned shall be considered in the development of:

1) corrective actions; and

2) preventive actions.

C) The organization shall take necessary corrective action based on the findings of investigations.

D) The organization shall prioritize and implement corrective action(s) in a timely manner.

E) The organization shall prioritize and implement preventive action(s) in a timely manner.

F) Records shall be kept of the disposition and status of corrective and preventive actions per established record retention policy.

6.7. Management Reviews

A) Top management will conduct regular reviews of the SMS, including:

1) the outputs of SRM (Section 5);

2) the outputs of safety assurance (Section 6); and

3) lessons learned (Section 7.5).

B) Management reviews shall include assessing the need for changes to the organization's:

1) operational processes, and

2) SMS.

6.8 Continual Improvement

The organization shall continuously improve the effectiveness of the SMS and of safety risk controls through the use of the safety and quality policies, objectives, audit and evaluation results, analysis of data, corrective and preventive actions, and management reviews.

7. Safety Promotion

7.1. Safety Culture

Top management shall promote the growth of a positive safety culture through:

1) publication of senior management's stated commitment to safety to all employees;

2) visible demonstration of their commitment to the SMS;

3) communication of the safety responsibilities for the organization's personnel;

4) clear and regular communication of safety policy, goals, objectives, standards, and performance to all employees of the organization

5) an effective employee safety feedback system that provides confidentiality as is necessary;

6) use of a safety information system that provides an accessible efficient means to retrieve information; and

7) allocation of resources essential to implement and maintain the SMS.

7.2. Communication and Awareness

A) The organization shall communicate outputs of the SMS to its employees, as appropriate.

B) The organization shall provide access to the outputs of the SMS to its oversight organization, in accordance with established agreements and disclosure programs.

7.3. Personnel Requirements (Competence)

A) The organization shall document competency requirements for those positions identified in Section 4.5.D).

B) The organization shall ensure that those individuals in the positions identified in 4.5.D) meet those competency requirements.

7.4. Training

Training shall be developed for those individuals in the positions identified in 4.5.D).

1) Training shall include:

   a) initial training; and

   b) recurrent training.

2) Employees shall receive training commensurate with their:

a) Level of responsibility; and

b) impact on the safety of the organization's product or service.

3) To ensure training currency, it shall be periodically:

a) reviewed; and

b) updated.

7.5. Safety Lessons Learned

A) The organization shall develop safety lessons learned.

B) Lessons learned information shall be used to promote continuous improvement of safety.

C) The organization shall communicate information on safety lessons learned.

APPENDIX 2. COMPARISON OF SMS-P STANDARD WITH OTHER STANDARDS

1. PURPOSE OF THIS APPENDIX.

a. The table below is provided to assist those organizations developing and implementing an SMS. It provides a link between existing standards and this standard. It includes links to the following:

(1) Quality Management Systems via International Standards Organization (ISO) 9001:2000 and the Aerospace Basic Quality System Standard (AS 9100) requirements;

(2) Environmental Management Systems via ISO 14001 requirements; and

(3) Occupational Safety and Health Management Systems via OHSAS 18001. (NOTE: OHSAS 18001 is an Occupation Health and Safety Assessment Series for health and safety management systems, which was created through a concerted effort from a number of the world's leading national standards bodies, certification bodies, and specialist consultancies.)

b. The table is intended to assist the developer in building on existing management systems to develop the SMS and/or integrating its SMS with these existing management systems.

2. SMS-P STANDARD COMPARED WITH OTHER STANDARDS.

Content (Standards)	SMS-P Standard	ISO 9001:2000/ AS 9100	ISO 14001	OHSAS 18001
Scope and application	1	1	1	1
References (Normative)	2	2	2	2
Definitions	3	3	3	3
Management system description	4	4	4	4
General requirements (and Responsibility/Authority (ISO 9000))	4.1	4.1, 5.5	4.1	4.1
Policy (safety, environmental, quality)	4.2, 4.3	5.1, 5.3, 8.5	4.2	4.2
Planning	4.4	5.4	4.3	4.3
Requirements (hazard/risk, environmental aspects, customer requirements)	5	5.2, 7.2.1, 7.2.2	4.3.1	4.3.1
Legal and other requirements, customer focus (ISO 9000)	4.6	5.2, 7.2.1	4.3.2	4.3.2
Objectives and targets	4.2.B), 5D.	5.4.1	4.3.3	4.3.3

Content (Standards)	SMS-P Standard	ISO 9001:2000/ AS 9100	ISO 14001	OHSAS 18001
Programs, action planning to meet targets, continual improvement	4.1.A), 4.4, 5.5	5.4.2, 8.5.1	4.3.4	4.3.4
Management responsibility and organizational structure	4.5	5, 6 (Resource mgmt.)	4.4.1	4.4.1
Training	7.3, 7.4	6.2.2	4.4.2	4.4.2
Communications	6.3.6, 7.2, 7.5	5.5.3, 7.2.3	4.4.3	4.4.3
Documentation and quality manual (ISO 9000)	4.9	4.2	4.4.4	4.4.4
Document and data control	4.9	4.2.3	4.4.5	4.4.5
Operational control and product realization	4.7	7	4.4.6	4.4.6
Emergency preparedness and response, control of nonconforming product (ISO 9000)	4.8	8.3	4.4.7	4.4.7
Performance measurement and monitoring	4.1, 6.3.1, 6.4, 6.5	8	4.5	4.5
Accidents, incidents, nonconformity, corrective and preventive action	6.3.5, 6.5, 6.6	8.3, 8.5.2, 8.5.3	4.5.2	4.5.2
Auditing	6.3.3 – 6.3.5	8.2.2	4.5.4	4.5.4
Management review	6.7	5.6	4.6	4.6
Continual Improvement	6.8	8.5.1	4.3.4	4.3.4