Safety Management Systems and Aviation Technologies in the Helicopter Emergency Medical Services Industry

Aviation Human Factors and Safety Management Systems Wings Seminar

Real-World Flight Operations and Research Progress

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Presentation Agenda

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Background

- **The first practical use of civilian air medical rotor-wing service in the U.S. began in 1970s (McGinnis et al., 2007)**
- **In 1980, there were 40 HEMS operators in existence and operations consisted of two to three pilots (FAA Accident Task Force, 2004)**
- **Association of Air Medical Services indicated there are 658 EMS operators in the U.S. flying over 400 aircraft and 300,000 patients each year (McGinnis et al., 2007)**
- **In 1980, there were 32 HEMS programs flying 17,000 patients a year In 1987, there was a 400% increase in the number of operations. Ten years later, 231 helicopter services with 400 aircrafts were flying over 203,000 patients each year (McGinnis et al., 2007)**
- **In 1995, there were 293 aircrafts operating. In 2006, the industry had grown to 792 aircraft, with the majority of that growth between 2001 and 2006 (NTSB, 2011)**

Background

- **Studies have shown that the risk of Emergency Medical Services (EMS) helicopter accidents have more than tripled (Jenabzadeh & Warner, 2007)**
- **HEMS helicopters in the United States fly approximately 400,000 flight hours annually**
- **Escalation in the frequency of air-medical helicopter accidents has occurred (Jenabzadeh & Warner, 2007)**
- **The rate of fatal HEMS accidents in 2008 was distinguished that year as the deadliest on record (NTSB, 2011)**

Background (cont.)

- **Part 121 accident rate increased from 3.53 accidents per 100,000 flight hours in 1992 to 4.56 accidents per 100,000 flight hours between 1997 and 2001 (McGinnis et al., 2007)**
- **Commercial air carrier aviation accident rates were 0.146 accidents per 100,000 flight hours in 1992 to 0.309 accidents per 100,000 flight hours (NTSB, 2011)**
- **In 2011, accident rates and fatality rates for 14 CFR, 121 operations were 0.159 and 0.006, respectively**
- **Compared to other aviation career categories, HEMS fatality rates have been higher than all others combined (Jenabzadeh & Warner, 2007)**

Problem

The problem has been that while studies have been conducted on empirical efficacy strategies to mitigate the high rate of HEMS accidents

- **It remains unknown whether an increased focus on safety systems and technologies will result in fewer HEMS accident rates**

Research Questions

- **Q1. What associations exist among frequency of accidents at HEMS organizations and implementation of safety management systems?**
- **Q2. What associations exist among utilization of aviation technologies and frequency of HEMS accidents rates?**

Purpose

The purpose of this quantitative correlational study was to investigate whether associations exist among safety management systems implementation, aviation technologies utilization (predictor variables), years of experience, and the frequency of HEMS accident rates (criterion variable) within HEMS organizations

Significance

- **HEMS accidents rates have been disproportionate compared to other commercial air carrier aviation accident and fatality rates (Jenabzadeh & Warner, 2007)**
- **No research on the relationships among the use of safety management systems, available aviation technologies, and frequency of HEMS accident rates**
- **It is known that most HEMS accidents are caused by pilot errors (NTSB, 2011)**

Historical Data

- **Human error has been shown to account for about 60% to 85% of all accidents (Shappell et al., 2007)**
- **Human factors have been shown to account for 42.2% of operational errors. 40.8% of those operational errors were errors of decision-making or judgment (Jenabzadeh & Warner, 2007)**
- **Human error has been cited as a major contributing factor in accidents, and incidents and surveys have attributed 70% of incidents to crew error (Masys, 2008)**
- **Researchers suggested there is a potential correlation between effective HEMS transportation of patients and implementation of safety management systems (Ringburg et al., 2009)**
- **Researchers maintained that the utilization of safety management systems and aviation technologies can help in the transformation of organization safety (Iani & Wickens, 2007)**

Historical Data

- **During a 22-year period from 1983 to 2005, 71 accidents (39% of all accidents) resulted in fatalities. The first decline in the frequency of accidents occurred in 2006 with 2 (1%) less than in 2005, while the number of aircraft increased by 39 (5%) in the same year.**
- **Through a series of preventive safety programs initiated by the FAA, the accident trend reversed itself. By the mid to late 1990s, however, the accident trend began to rise again.**
- **NTSB records have revealed several alarming statistics regarding helicopter EMS crashes over a 22-year period where these crashes resulted in one or more deaths. Of the 182 crashes that occurred during this period, 71, or 39%, resulted in a fatality.**
- **In 1987, the FAA initiated a series of HEMS operator base inspections, consisting of intensive reviews of field standard operating procedures, aircraft, personnel, and records. Several data points were identified, including training, safety, and standardization.**

Research Design and Method

- **The quantitative correlational study investigated whether associations existed among safety management systems implementation, aviation technologies utilization, and the frequency of HEMS accident rates within HEMS organizations**
- **National EMS Pilot's Association (NEMSPA) announced the study to its membership database and provided a link to the survey on a section of the NEMSPA website that was available to HEMS pilots**
- **Curt Lewis and Associates also distributed the announcement via it's membership database**

Research Design and Method

- **There are approximately 4,000 HEMS pilots in the United States**
- **The study employed convenience sampling as its sampling method.**
- **800 emails were distributed, and 147 (18.2%) participants responded to the survey**
- **The survey included a list of all possible aviation technologies, and which technologies were utilized**

Research Design and Method

- **Correlational method assessed the associations among the study variables**
- **Nature of relationships and dependence on multiple linear regression methodology were explored**
- **SMS and aviation technologies (predictor variables) and HEMS accidents (criterion variable) rates in the HEMS industry were analyzed**
- **Study employed a convenience sampling methodology to select a group of subjects**

Data Analysis

- **Pearson R correlation analysis**
- **Linear multiple regression model**
- **SPSS Version 20 was used for data processing and analysis**
- **Multivariate regression was used to determine if any of the predictor variables significantly predicted accident rates**

Findings

- **The majority of participants were**
  - **Male (97 %), age 51-60 (54%)**
  - **Thirty-nine were within the age group of 41-50 years (27%)**
  - **Sixty-four participants reported years of experience in the HEMS industry as 10 or more years (43.5%). Followed by 7-9 years (26%), and**
  - **4-6 years (17.7%)**

Findings

Years Experience

Characteristic		Frequency		Percent		Valid Percents
Unknown		3		2.0		2.0
1-3		15		10.2		10.2
4-6		26		17.7		17.7
7-9		39		26.5		26.5
10 or more		64		43.5		43.5

Findings

- **$H1_0$. There is no relationship between the frequency of accident rates at HEMS organizations and the level of safety management systems implementation**
- **$H1_a$. There is a significant relationship between the frequency of HEMS accident rates at HEMS organizations and the safety management systems implementation**

Findings

- **Results from Pearson R correlation coefficient analysis confirmed and identified three significant positive relationships between the variables**
  - **HEMS years of experience had a high significant positive relationship with Accident Rate (r=.90, p<.05)**
  - **SMS had a moderate significant positive relationship to NVG (r=.38, p<.05), and**
  - **SMS had a slight significant positive relationship with TAWS (r=.234, p<.05)**
- **The null hypothesis was rejected and support existed for the alternative hypothesis**

Findings

- **$H2_0$. There is no relationship between the frequency of accidents at HEMS organizations and the level of implementation of aviation technologies**

- **$H2_a$. There is a significant relationship between the frequency of accidents at HEMS organizations and the level of implementation of aviation technologies**

Findings

- **The regression analysis suggested that:**
  - **HEMS years of experience explained a significant percentage of the variance in accident rate scores (R^2 = .814, F(2, 127) = 139.209, p<.05)**
  - **HEMS years of experience was also found to be a significant predictor of accident rates (b = .894, t(129) = 23.281, p<.05)**
- **The regression model was statistically significant HEMS years of experience, accounted for most of the variance, while NVG and TAWS accounted for a minimal level of variance.**
- **The regression model was significant (p<.05) to explain 81.4% of the variance of accident rate**
- **The null hypothesis was rejected and support existed for the alternative hypothesis**

HEMS Accident Rates

Year				Total Hrs	Total Accidents	Accident Rate*
1999						
Rotorcraft: Total	302,192			302,192	9	2.978
% Std. Error	17.3			17.3		
2000						
Rotorcraft: Total	296,191			296,191	13	4.389
% Std. Error	15.5			15.5		
2001						
Rotorcraft: Total	250,187			250,187	14	5.595
% Std. Error	13.3			13.3		
2002						
Rotorcraft: Total	261,085			261,085	12	4.596
% Std. Error	11.7			11.7		
2003						
Rotorcraft: Total	305,105			305,105	19	6.227
% Std. Error	10.3			10.3		
2004						
Rotorcraft: Total	54,965		322,722	377,687	13	3.44
% Std. Error	11.4		5.5	16.9		
2005						
Rotorcraft: Total	63,265		419,233	482,498	13	2.694
% Std. Error	9.6		5.8	15.4		
2006						
Rotorcraft: Total	46,700		487,090	533,790	13	2.435
% Std. Error	9.7		3.9	13.6		
2007						
Rotorcraft: Total	56,699		242,183	298,882	11	3.68
% Std. Error	11.6		5.5	17.1		
2008						
Rotorcraft: Total	42,996		385,228	428,224	10	2.335
% Std. Error	9.7		4.1	13.8		
2009						
Rotorcraft: Total	34,379		271,715	306,094	9	2.94
% Std. Error	11.5		4.7	16.2		
2010						
Rotorcraft: Total	41,551		425,759	467,310	11	2.353
% Std. Error	9.5		5.3	14.8		

Accidents rates are defined as the number of accidents divided by the total number of flight hours

Implications

- **The study results indicated evidence to suggest that a statistically significant relationship existed with HEMS years of experience, NVG, and TAWS in HEMS accident reduction**
- **The findings of this study also showed that the level of organizational safety culture and level of SMS implementation are possibly related to the reduction of HEMS accidents**
- **The results indicated that even though one variable, HEMS years of experience was statistically significant predictor of accidents rates, NVG and TAWS were at best slight to moderate significant predictors**

Implications

- **The regression model was statistically significant for HEMS years of experience and slightly and moderately significant for NVG and TAWS respectively**
- **This finding implied that in HEMS accidents and years of experience, NVG and TAWS were statistically significant and related to each other**
- **These results implied that further research was needed to explore the influence these variables would have on the reductions of accidents in the HEMS industry**

Recommendations

- **Further inferential research is recommended to ascertain whether SMS and aviation technologies utilization in the HEMS industry can influence HEMS accident reduction**
- **Recommend the HEMS industry adopt the current ICAO framework and existing FAA regulatory guidance for implementation of SMS programs**
- **Recommend the FAA support the HEMS industry by publishing the remaining NTSB recommendations**
- **Recommend HEMS organizations continue to re-evaluate their current and future operational strategies**

Recommendations

- **Additional research to confirm these findings is recommended.**
- **Recommend additional research be conducted utilizing the current variables in this study to include the same data collection instrument**
- **Final recommendation for the FAA and NTSB to continue to work collaboratively within the industry to develop regulatory provisions**
- **Comprehensive understanding of how HEMS operator's perspectives can differ in their approach to aviation safety culture**

Recommendations

- **Recommend that alternative variables be included in future research and analyzed to explore the influences and applicability of these variables**
- **Future additional research to ascertain if HEMS pilots can actually perceive NVGs, TAWS, and SMS as risk mitigation tools**
- **Recommend that additional quantitative studies involving a larger population sample could be useful to assess and further explain the large variance in this study**

FY 13 – U.S. Registered Rotorcraft Accidents

Cumulative Rotorcraft Accidents – 113 (29 Fatal Accidents, 59 Fatalities)

Same period previous FY: 89 Total Helicopter Accidents (12 Fatal Accidents, 26 Fatalities)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Accidents:	16	11	11	12	10	11	11	13	18				113
Fatal:	4	5	2	3	3	4	2	2	4				29
Fatalities:	7	7	4	11	6	8	3	4	9				59

Data Source: FAA, NTSB Databases. Includes only events classified as accidents and does not include incidents. The accident numbers for each month of the Fiscal Year may vary from the previous monthly briefing based on analysis between FAA and NTSB databases for the specified month. The NTSB database may include accidents that were not reported to this office resulting in slightly different numbers.

Accident Operations Summary *(Cumulative)*

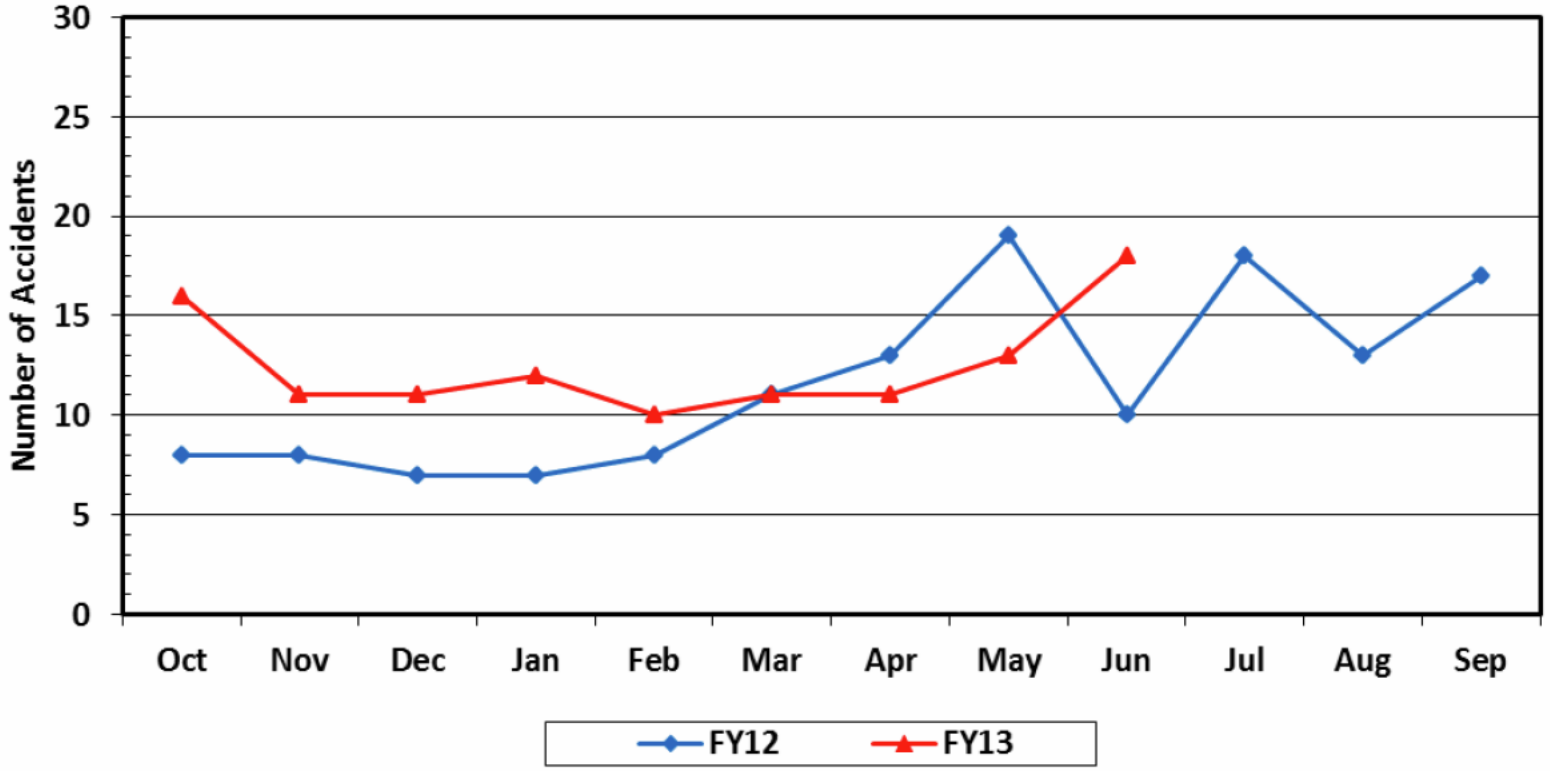
	EMS 91/ 135	GOM 91/ 135	Part 133	Part 135 Other	Air Tour 135/136	Part 137	ENG 91/ 135	GA 91	N Reg Outside U.S.
Accidents:	9	4	4*	1	1	8		83+	3
Fatal:	5	2	1*	0	0	1		17+	3
Fatalities:	12	4	1*	0	0	1		29+	12

*Includes 1 fatal Utilities Patrol accident with human external load

+Includes 1 fatal Aerial Application Part 91 frost control flight, 1 fatal Aerial Application Public Use grass seeding flight

Acronyms: EMS = Emergency Medical Services, ENG = Electronic News Gathering, GA = General Aviation, GOM = Gulf of Mexico

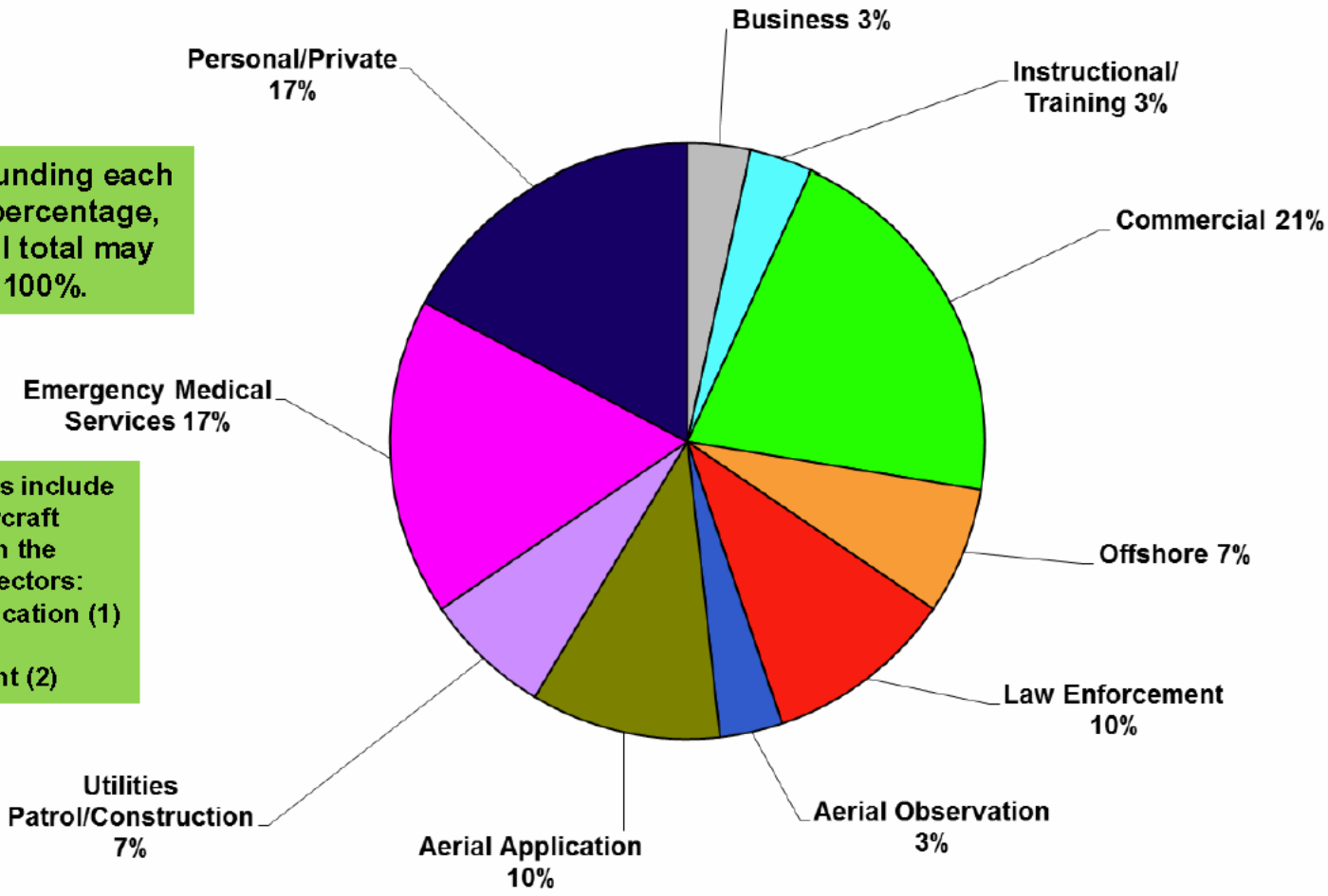
U.S. Registered Rotorcraft Accidents: FY13 Comparison to FY12



FY 13 – Total FATAL Accidents by Industry (Oct 2012 – June 2013)

Due to rounding each Industry percentage, the overall total may not equal 100%.

Percentages include 3 Public Aircraft accidents in the following sectors: Aerial Application (1) and Law Enforcement (2)



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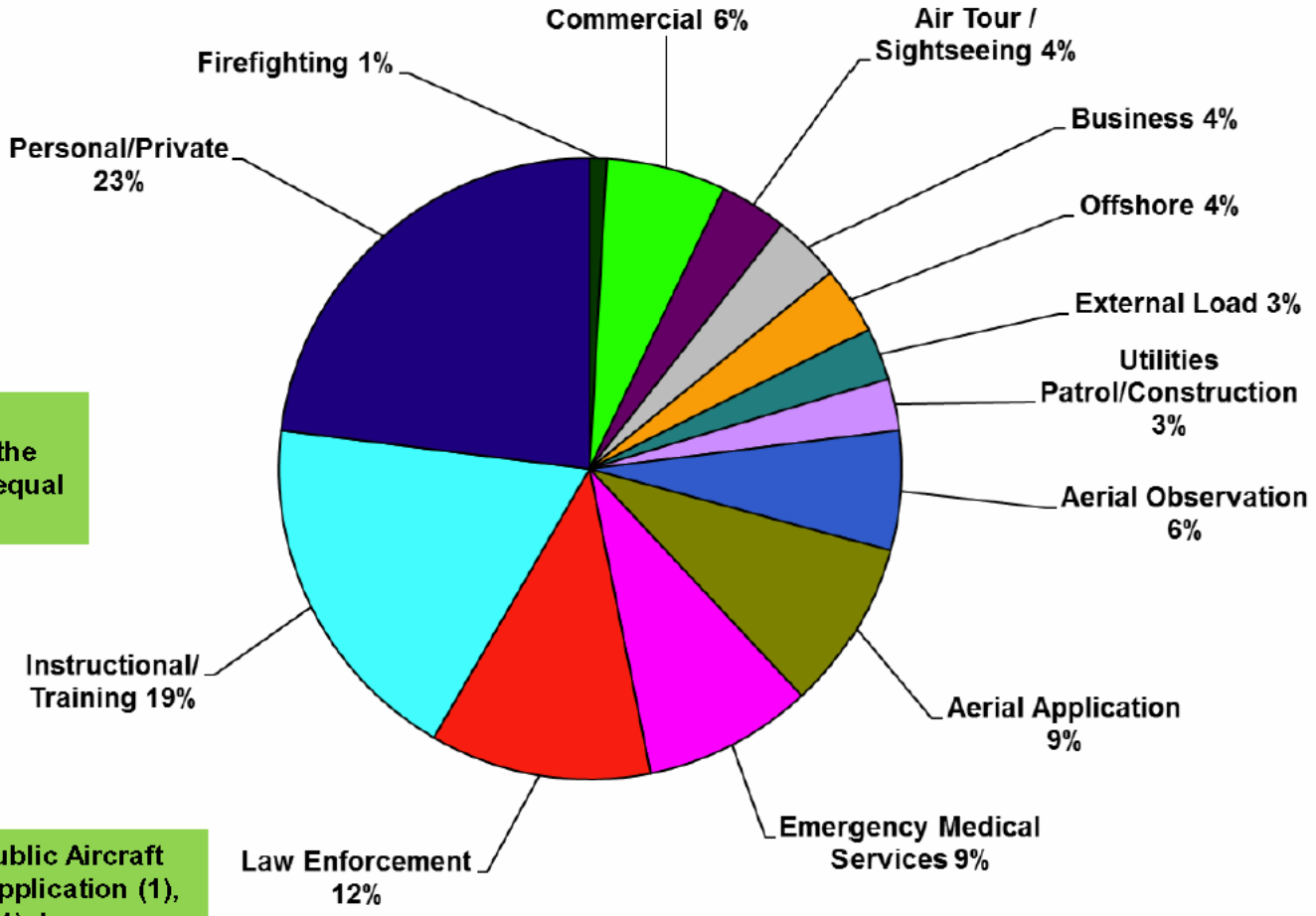

Due to rounding each Industry percentage, the overall total may not equal 100%.

Chart includes 13 Public Aircraft accidents : Aerial Application (1), Aerial Observation (1), Law Enforcement (11)

Questions and Comments