COMPARATIVE REPORT, Volume 1

U.S. JHIMDAT Data to U.S. JHSAT Data

U.S. Joint Helicopter Implementation Measurement Data Analysis Team

To

The United States Helicopter Safety Team

March 2014

The U.S. JHSAT analyzed 523 U.S. registered helicopter accidents that occurred in CY2000, CY2001 and CY2006 (JHSAT data). The U.S. JHIMDAT analyzed 415 U.S. registered helicopter accidents that occurred in CY2009-2011 (JHIMDAT data). This report contains the comparative JHIMDAT data to JHSAT data analysis. The purpose was to identify differences of statistical significance. By noting areas of improvement, regression, and stagnation, this analysis allowed the opportunity for a strategic approach to future helicopter accident rate reduction efforts.

Table of Contents

List of Tables

List of Figures

U.S. JHIMDAT Members

The following JHIMDAT Member organized the data, conducted the comparative analysis, and wrote the comparative report between the JHIMDAT and JHSAT data.

Name	Company/Organization
Lee Roskop	FAA Rotorcraft Standards Staff

The following JHIMDAT Members contributed to one or all of the following activities: analysis of the JHIMDAT data, review of the comparative report, and development of summary and conclusions.

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Description

In 2006, the U.S. Joint Helicopter Safety Analysis Team (JHSAT) began analysis work on U.S. accidents that occurred in calendar year 2000. After publishing a report with the results of their work, the JHSAT proceeded to complete comparable analysis on the U.S. accidents that occurred in 2001 and followed completion of that project with analysis of 2006. In 2011, the JHSAT consolidated the results of all three respective years into a compendium report (hereafter known in this report as "JHSAT data"). The JHSAT data established a baseline for future U.S. helicopter accident analysis.

As a follow up to the compendium report, the U.S. Joint Helicopter Implementation Measurement and Data Analysis Team (JHIMDAT) attempted to measure progress by comparing the JHSAT data to analysis performed on the three calendar years 2009-2011 (hereafter known in this report as "JHIMDAT data"). Analysis of the JHIMDAT data remained consistent with the JHSAT's methodology. However, the extensive depth of analysis performed on the JHSAT data required monthly meetings of one week duration that were no longer feasible for analysis of the JHIMDAT data. The JHIMDAT transitioned to quarterly meetings consisting of a much smaller team composition than the original JHSAT. To account for the realities of a smaller team that met less frequently, the JHIMDAT reduced the scope of the analysis effort. The team accomplished a "high level" analysis of the three years from 2009-2011 through quarterly meetings conducted over a 9 month period.

The JHIMDAT's preference would have been to use rate based comparisons in their analysis. The rate would have been calculated using accident counts as the numerator and flight hours as the denominator. However, while it was possible to make some reasonable estimates for the *total* U.S. rotorcraft flight hours, it was not possible to accurately refine that flight hour estimate across the numerous different analysis areas used by the JHIMDAT. With this limitation, the JHIMDAT made comparisons in their research based on accident counts that were converted to percentages to express frequency.

The JHIMDAT's intent was to find where meaningful differences existed between the JHIMDAT data and the JHSAT data. Areas where improvement occurred were candidates for exploring successful implementation measures for use in other areas where progress was less substantial. Areas where regression occurred or stagnation was evident were candidates for adapting different intervention strategies to encourage improvement. In either case, adjustments could be made to further the progress toward the 80% accident rate decrease sought by the IHST. Initial comparison of the JHIMDAT data and JHSAT data showed differences did exist. However, the JHIMDAT sought to further identify areas where ***statistically significant*** differences existed. The team opted for a chi squared analysis to support this purpose, based on the JHSAT's and JHIMDAT's method of organizing the accident analysis data according to a nominal scale. "Nominal scale" describes a grouping of data into various categories based on some common characteristic. A partial list of examples would include the following: 1) "Industry", such as Personal/Private, Instructional/Training, or Aerial Application; 2) "Activity" descriptions, such as Positioning/RTB, Instructional/Training (Dual), or Maintenance/Test flight; and 3) "Occurrence Categories", such as Loss of Control, Autorotation, or System Component Failure.

The chi squared analysis consisted of either a "goodness of fit" test (most cases) or a "test of homogeneity" (a few cases). The goodness of fit test allowed the team to directly compare one group of JHIMDAT data to the corresponding group of JHSAT data to assess statistical differences. The test of homogeneity was a slightly more complex approach that the team used for a few limited cases where the goal was to examine two categories (e.g., VMC or IMC) against two other categories (e.g., fatal accident or non-fatal accident). The test of homogeneity did not allow the same direct comparison of JHIMDAT data to JHSAT data as was possible with the goodness of fit test. However, a viable comparison was still possible in these cases according to the following method. The team first applied the test of homogeneity to identify whether a statistical difference existed within the JHSAT data, then applied the same test of homogeneity to the corresponding categories within the JHIMDAT data, and concluded by assessing if the results between the two data sets were similar or different. Also as part of the chi squared analysis (for both goodness of fit test and test of homogeneity), the team often used the standardized residual to determine what specific nominal data was a major contributor to driving the statistical difference. For example, if a statistical difference was found in the area of industry sectors, the standardized residual would identify the specific industry sectors most responsible for the statistical difference.

For each analysis scenario in this report, the JHIMDAT used the chi squared critical values associated with $p = .01$. The "p value" is associated with the probability of rejecting a null hypothesis that is actually true. The p values associated with measurements of statistical significance are typically .05 or less, so the JHIMDAT's use of $p = .01$ was consistent with using a rigorous standard to assess statistical significance. In the case of the JHIMDAT and JHSAT data comparison, the null hypothesis in each case was that there was *not* a difference between the nominal data from the JHIMDAT as compared to the nominal data from the JHSAT. In order to reject the null hypothesis for any of the areas studied in this report, the calculated chi squared value had to exceed the chi squared critical value for $p = .01$. Any time the team found a statistical difference in the JHIMDAT and JHSAT data, use of $p = .01$ meant that there was a 1% (or less) probability that our conclusion was incorrect and a statistical difference between the data did not exist.

A goal of the JHIMDAT was to produce a report that was succinct and easily read so that results from the report could be quickly translated by the readers into implementation. We sought to avoid a cumbersome and overly detailed document that would never be read. Consistent with this approach, the team separated the comparative analysis into two volumes. The intent was to ensure Volume 1 emphasized the most important aspects of the comparative analysis. The team intentionally truncated most of the tables in Volume 1 such that only the most frequently cited areas in the analysis were listed. The data suggested these areas could have the most significant impact on future accident reduction efforts. Volume 2 of the comparative analysis has the complete data tables for the reader who would like to explore the analysis at an additional level of detail. Volume 2 also includes some data tables that were limited to a textual summary in Volume 1.

Industry

Industry described the type of work or operation where the helicopter is *typically* used. The team categorized each accident from both the JHSAT data and JHIMDAT data by Industry into one of fifteen possible options. Table 1 lists the five most frequently cited Industry categories from the JHIMDAT data alongside the respective percentages from the JHSAT data. The Industry categories are listed in descending order of frequency based on the JHIMDAT column.

There were two separate chi squared analyses accomplished as related to Industry.

1) The team analyzed the aggregate group of JHIMDAT accidents as categorized by Industry against the aggregate group of JHSAT accidents categorized by Industry. The conclusion was the two data sets were statistically different. Major contributors to the statistical difference were the increase in the proportion of Aerial Application accidents and the decreases in the proportions of Firefighting, Logging, and Electronic News Gathering accidents.

2) The team conducted a separate, individual analysis of each specific Industry segment comparing the two data sets. As shown in Table 1, Aerial Application was the only one of the five most frequently occurring Industry categories where a statistically significant difference existed between the JHSAT data and the JHIMDAT data. In that particular case, the team found a statistically significant increase in accidents.

Table 1. Industry Comparison

Industry	JHIMDAT (CY09-11): 415 Accidents	JHSAT (CY00-01, 06): 523 Accidents
Personal/Private	20.7% (86)	18.5% (97)
Instructional/Training	20.5% (85)	17.6% (92)
Aerial Application	15.7% (65)	10.3% (54)
Emergency Medical Services	8.0% (33)	7.6% (40)
Commercial	7.5% (31)	7.5% (39)

[red] Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

[green] Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

[white] Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

Activity

Activity is different from Industry in that it described the specific function the helicopter was engaged in at the time the accident actually occurred. The team categorized each accident from both the JHSAT data and JHIMDAT data by Activity into one of twenty-seven possible options. Table 2 lists the five most frequently cited Activity categories from the JHIMDAT data alongside the respective percentages from the JHSAT data. The Activity categories are listed in descending order of frequency based on the JHIMDAT column.

There were two separate chi squared analyses accomplished as related to Activity.

1) The team analyzed the aggregate group of JHIMDAT accidents as categorized by Activity against the aggregate group of JHSAT accidents categorized by Activity. The conclusion was the two data sets were statistically different. Among some of the major contributors to the statistical difference was the increase in the proportion of accidents in the following Activities: Instructional/Training (Dual), Personal/Private, and Instructional/Training (Solo).

2) The team conducted a separate, individual analysis of each specific Activity comparing the JHIMDAT data to the JHSAT data. The results for the five most frequently occurring Activities are in Table 2. Both Instructional/Training (Dual) and Personal/Private showed statistically significant increases.

Table 2. Activity Comparison

Activity	JHIMDAT (CY09-11): 415 Accidents	JHSAT (CY00-01, 06): 523 Accidents
Instructional / Training (Dual)	19.3% (80)	14.0% (73)
Personal/Private	17.8% (74)	12.4% (65)
Positioning/RTB	13.7% (57)	13.2% (69)
Aerial Application - Spraying/Disbursing	8.9% (37)	8.0% (42)
Instructional / Training (Solo)	5.3% (22)	3.3% (17)

Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

Industry and Activity Pairs

The combination of the Industry category for each accident and the Activity category for each accident can be paired together to refine the understanding of the accidents that happened. This pairing resulted in ninety-seven Industry and Activity combinations that were used in the JHIMDAT and JHSAT analysis. Table 3 lists the thirteen most frequently occurring Industry and Activity pairs from the JHIMDAT data alongside the respective percentages from the JHSAT data. The Industry and Activity pairs are listed in descending order of frequency based on the JHIMDAT column.

The team accomplished two separate chi squared analyses as related to Industry and Activity pairs.

1) We analyzed the aggregate group of JHIMDAT accidents as categorized by Industry and Activity pairs against the aggregate group of JHSAT accidents categorized by Industry and Activity pairs. The conclusion was the two data sets were statistically different. Among some of the major contributors to the statistical difference was the increase in the proportion of accidents in the following Industry and Activity pairs: Personal/Private – Personal/Private, Instructional/Training - Instructional/Training (Solo), and Aerial Application – Positioning/RTB.

2) The team attempted a separate, individual analysis to compare the data sets for each of the top thirteen Industry and Activity pairs. However, an accurate individual analysis was only possible for seven of the thirteen pairs. For the remaining six pairs, some calculations associated with the chi squared analysis in these cases resulted in numbers below the minimum acceptable values necessary to ensure an accurate statistical calculation. The six Industry and Activity pairs excluded from the analysis are annotated accordingly in Table 3. The only statistical difference among the seven pairs that were individually analyzed was a statistically significant increase in Personal/Private – Personal/Private.

The tenth most frequently occurring Industry and Activity pair from the JHIMDAT data shown in Table 3 was Aerial Application/Aerial Application – Other. Since the “Other” designation is nondescript with the potential for various interpretations, the team determined the following clarifying definition was appropriate. Aerial Application – Other described an Aerial Application accident where it was either unclear what activity the pilot was engaged in at the time of the crash or the activity the pilot was engaged in was so infrequent it did not warrant a more specific Activity category.

Table 3. Industry and Activity Pairs Comparison

Industry	Activity	JHIMDAT (CY09-11): 415 Accidents	JHSAT (CY00-01, 06): 523 Accidents	
Personal/Private	Personal/Private	17.8% (74)	12.0% (63)	
Instructional/Training	Instructional/Training (Dual)	15.2% (63)	13.6% (71)	
Aerial Application	Aerial Application - Spraying/Disbursing	8.9% (37)	8.0% (42)	
Instructional/Training	Instructional / Training (Solo)	4.3% (18)	2.7% (14)	
Emergency Medical Services	Positioning/RTB	4.1% (17)	5.5% (29)	
Aerial Application	Positioning/RTB	3.4% (14)	1.1% (6)	X
Commercial	Passenger/Cargo (Commercial)	2.7% (11)	3.3% (17)	
Law Enforcement	Instructional/Training (Dual)	2.7% (11)	0.4% (2)	X
External Load	External Load - Line	2.4% (10)	2.5% (13)	
Aerial Application	Aerial Application - Other	2.4% (10)	1.0% (5)	X
Offshore	Passenger/Cargo (Commercial)	2.2% (9)	2.1% (11)	X
Emergency Medical Services	Emergency Medical Services	1.9% (8)	1.1% (6)	X
Aerial Observation	Aerial Observation - Fish/Game Spotting	1.9% (8)	1.0% (5)	X

Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

X Excluded from individual chi squared analysis

Occurrence Category

Occurrence Categories provided a concise description of "what happened" in an accident. Table 4 lists the nine most frequently cited Occurrence Categories from the JHIMDAT data alongside the respective percentages from JHSAT data. The table lists the Occurrence Categories in descending order of frequency based on the JHIMDAT column.

A chi squared analysis that compared the aggregate group of JHIMDAT to JHSAT accidents by Occurrence Categories was not possible using the same format as the Industry and Activity data. This is because each accident was not limited to assignment in a single Occurrence Category. Both the JHSAT and JHIMDAT methodology allowed each individual accident to be coded with up to four different Occurrence Categories. This aspect of the methodology explains why the percentages of Occurrence Categories from each data set should not be summed with the expectation of the result totaling 100%. Multiple Occurrence Categories per accident ensured the summed total will far exceed 100%.

However, the team was able to perform a separate, individual chi squared analysis for each Occurrence Category. For each case, this was possible by grouping all accidents where an Occurrence Category had been used at least once into one set of data (e.g., all Loss of Control accidents), while grouping all accidents where that same Occurrence Category was never used into another set of data (e.g., all accidents where Loss of Control was not cited). The results for the nine most frequently occurring Occurrence Categories are in Table 4. Loss of Control and Controlled Flight Into Terrain (CFIT) showed statistically significant increases while Systems Component Failure (SCF) showed a statistically significant decrease.

The team decided further explanation was needed for one of the Occurrence Categories in Table 4. Although Abnormal Runway Contact (ARC) is listed as the third most frequently assigned Occurrence Category in the JHIMDAT data, it was excluded from the individual chi squared analysis. The team assigned ARC to 24.6% of the accidents in the JHIMDAT data as compared to 7.6% of the accidents in the JHSAT data. It would appear the Occurrence Category is a clear candidate for assessing whether a significant statistical difference existed. However, the JHIMDAT attributed this relatively large difference in proportions to a different understanding and assignment of the ARC category in the JHIMDAT analysis as opposed to how it was previously used in the JHSAT analysis. The JHIMDAT did not think there was an actual increase in the cases of ARC; rather, there was a different application of the Occurrence Category by the JHIMDAT. This led to inconsistency in how it was assigned in the JHIMDAT data when compared to the earlier JHSAT work.

Table 4. Occurrence Category Comparison

Occurrence Category	JHIMDAT (CY09-11): 415 Accidents	JHSAT (CY00-01, 06): 523 Accidents
LOC - Loss of Control	47.5% (197)	41.5% (217)
AUTO - Autorotation	32.8% (136)	31.7% (166)
ARC - Abnormal Runway Contact	24.6% (102)	7.6% (40)
SCF - System Component Failure	21.4% (89)	27.5% (144)
STRIKE	19.8% (82)	16.4% (86)
FUEL	8.2% (34)	7.6% (40)
VIS - Visibility	8.0% (33)	10.7% (56)
FIRE	7.0% (29)	6.1% (32)
CFIT - Controlled Flight into Terrain	6.7% (28)	3.1% (16)

Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

X Abnormal Runway Contact excluded from individual chi squared analysis

Sub-Occurrence Category

The Sub-Occurrence Category served the purpose of providing a more detailed description within each Occurrence Category. Table 5 lists the eleven most frequently assigned Occurrence Category/Sub-Occurrence Category pairs from the JHIMDAT data alongside the respective percentages from JHSAT data. The table lists the Occurrence Category/Sub-Occurrence Category pairs in descending order of frequency based on the JHIMDAT column.

For the same reasons noted in the Occurrence Category portion of the report, a chi squared analysis that compared the aggregate group of JHIMDAT to JHSAT accidents by Occurrence Category/Sub-Occurrence Categories pairs was not possible.

However, the team did perform a separate, individual chi squared analysis for each Occurrence Category/Sub-Occurrence Category pair. For each case, this was possible by grouping all accidents where a pair had been used at least once into one set of data, while grouping all accidents where that same pair was never used into another set of data. The results for the eleven most frequently cited Occurrence Category/Sub-Occurrence Category pairs are in Table 5. Four of the top eleven most frequently cited pairs showed a statistically significant increase in the proportion of accidents. System Component Failure – Helicopter was the one Industry/Activity pair that showed improvement as evident by the statistically significant decrease in accidents.

As also noted in the Occurrence Category section of the report, the team did not analyze the Sub-Occurrence Category of Abnormal Runway Contact (ARC) for a statistical difference. The explanation is the same as previously noted. The team did not think there was an actual increase in the cases of ARC; rather, there was a different application of the Occurrence Category by the JHIMDAT and this led to inconsistency in how it was assigned by the JHIMDAT when compared to the earlier JHSAT work.

Table 5. Sub-Occurrence Category Comparison

Occurrence Category / Sub-Occurrence Category	JHIMDAT (CY09-11): 415 Accidents	JHSAT (CY00-01, 06): 523 Accidents	
Abnormal Rwy Contact - Abnormal Rwy Contact	24.6% (102)	7.6% (40)	X
Autorotation - Emergency	22.9% (95)	21.8% (114)	
Loss of Control - Performance Management	21.7% (90)	15.1% (79)	
Autorotation - Practice	11.8% (49)	10.9% (57)	
Strike - Low Altitude Mission	8.7% (36)	5.5% (29)	
Strike - Takeoff or Landing	8.7% (36)	4.0% (21)	
Loss of Control - Dynamic Rollover	8.4% (35)	5.9% (31)	
System Component Failure - Engine	8.0% (33)	10.1% (53)	
System Component Failure - Helicopter	7.5% (31)	14.3% (75)	
CFIT - CFIT	6.7% (28)	3.1% (16)	
Fire - Post Impact	6.0% (25)	5.2% (27)	

Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

X Abnormal Runway Contact excluded from individual chi squared analysis

Joint Aircraft System/Component (JASC) Codes

The original JHSAT data delineated System Component Failure (SCF) accidents into one of four categories: 1) Engine, 2) Helicopter, 3) Mission Equipment, or 4) Unconfirmed/Perceived. The JHIMDAT sought to expand on the specificity associated with SCF accident analysis through use of JASC codes. The team included a JASC Code analysis for the 89 SCF accidents from the JHIMDAT data (comprising 21.4% of the 415 total accidents) and then returned to the original JHSAT data and did likewise for the 144 SCF accidents (comprising 27.5% of the 523 total accidents). The team used thirty-nine different four digit JASC Codes in the JHIMDAT data and fifty-six different four digit JASC Codes in the JHSAT data.

Because of the many different JASC Codes used between the two data sets, the team had to consolidate them in order to accomplish an accurate statistical comparison between the JHIMDAT and the JHSAT data. We sorted the variety of JASC Codes into three general categories. Table 6 lists the consolidated JASC Code categories from the JHIMDAT data alongside the respective percentages from the JHSAT data. The JASC Codes are listed in descending order of frequency based on the JHIMDAT column.

There were two separate chi squared analyses accomplished as related to JASC Code.

1) The team analyzed the aggregate group of JHIMDAT accidents as categorized by JASC Code against the aggregate group of JHSAT accidents categorized by JASC Code. The conclusion was the two data sets were not statistically different.

2) The team conducted a separate, individual analysis for each of the JASC Code categories in Table 6. Each of the consolidated categories was compared to all accidents where that consolidated category of JASC Codes was *not* used. As shown in Table 6, there was not a statistically significant difference between the JHSAT data and the JHIMDAT data for any of the three categories.

Table 6. JASC Codes

JASC Description	JHIMDAT (CY09-11): 89 SCF Accidents	JHSAT (CY00-01, 06): 144 SCF Accidents
Powerplant Systems (7000, 8000 series)	55.1% (49)	45.8% (66)
Rotor Systems (6000 series)	29.2% (26)	38.2% (55)
Airframe Systems (2000, 3000, 4000, 5000 series)	15.7% (14)	16.0% (23)

Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

Initiator of System Component Failure (SCF)

The JHIMDAT observed that each System Component Failure (SCF) had an initiating event. The team designated this event as the Initiator of SCF and found that four major categories existed: Maintenance Error, Manufacturing Error, Pilot Error, or Unknown. Table 7 has the four categories organized in descending order of frequency based on the JHIMDAT column. Identical to the JASC Code analysis, note that the percentages shown in the table are based only on the subset of ***SCF*** accidents. This consisted of 89 accidents from the JHIMDAT data (21.4% of the 415 total accidents) and 144 accidents from the JHSAT data (27.5% of the 523 total accidents).

There were two separate chi squared analyses accomplished as related to the Initiator of SCF.

1) The team analyzed the aggregate group of JHIMDAT accidents categorized by the Initiator of SCF against the aggregate group of JHSAT accidents categorized by the Initiator of SCF. The conclusion was the two data sets were statistically different. Major contributors to the statistical difference were the increase in the proportion of accidents where the Initiator of SCF was Unknown and the decrease in the proportion of accidents where the Initiator of SCF was Manufacturing Error.

2) The team attempted a separate, individual analysis for each specific Initiator of SCF comparing the JHIMDAT data to the JHSAT data. The results are in Table 7. Of note, however, is that the team had to exclude the Pilot Error category from individual analysis. This was necessary because some calculations associated with the chi squared analysis with the Pilot Error category resulted in numbers below the minimum acceptable values needed to ensure an accurate statistical calculation.

The statistically significant increase in the Unknown category of the JHIMDAT data inhibited the ability to draw more meaningful conclusions from the analysis. The Unknown category effectively masks the true proportions of accidents in the more descriptive categories associated with Initiator of SCF. For example, note that the Initiator of SCFs attributable to Manufacturing Error showed a statistically significant decrease between data sets. However, it is possible the decrease was artificial. We did not know how many of the accidents within the Unknown category may have actually been attributable to Manufacturing Error if more investigative information had been available. So, Manufacturing Error may have shown a true statistically significant decrease, or the decrease may have been artificial if more Manufacturing Error cases were hidden in the Unknown category. This same condition could have affected the results of the Maintenance Error and Pilot Error categories.

Table 7. Initiator of System Component Failures (SCFs)

Iniator of SCF	JHIMDAT (CY09-11): 89 SCF Accidents	JHSAT (CY00-01, 06): 144 SCF Accidents	
Unknown	44.9% (40)	18.1% (26)	
Maintenance Error	40.4% (36)	50.7% (73)	
Manufacturing Error	7.9% (7)	21.5% (31)	
Pilot Error	6.7% (6)	9.8% (14)	X

Denotes statistically significant increase in proportion of accidents from JHSAT data to JHIMDAT data

Denotes statistically significant decrease in proportion of accidents from JHSAT data to JHIMDAT data

Denotes no statistically significant change in proportion of accidents from JHSAT data to JHIMDAT data

X Excluded from individual chi squared analysis

General Accident Characteristics

The JHIMDAT also compared the following traits between the two data sets: Type Engine Installed, Accidents by Month, Weather Condition, and Light Condition.

Type Engine Installed

The team grouped accidents from both the JHIMDAT data and the JHSAT data into one of three categories of installed engine or engines: turbine twin, turbine single, or reciprocating. We analyzed the aggregate group of JHIMDAT accidents as categorized by Type Engine Installed against the aggregate group of JHSAT accidents categorized by Type Engine Installed. The conclusion was the two data sets were statistically different. Major contributors to the statistical difference were the increase in the proportion of accidents where rotorcraft had a reciprocating engine installed and the decrease in the proportion of accidents where rotorcraft had twin turbine engines installed.

Accidents by Month

The team grouped accidents from both data sets based on the month of occurrence. We analyzed the aggregate group of JHIMDAT accidents as categorized by month of occurrence compared to the aggregate group of JHSAT accidents categorized by month of occurrence. There was not a statistical difference between the two data sets.

The team also attempted a separate, individual analysis of accidents by month for each of the five most frequently cited Industry categories: 1) Personal/Private, 2) Instructional/Training, 3) Aerial Application, 4) EMS, and 5) Commercial. However, an accurate individual analysis was only possible for Instructional/Training. For the remaining four Industry categories, some calculations associated with the chi squared analysis for each case resulted in numbers below the minimum acceptable values necessary to ensure an accurate statistical calculation. Instructional/Training showed a statistically significant difference from the JHSAT data to the JHIMDAT data. The major contributors to the statistical difference in Instructional/Training accidents by month were an increase in the proportion of accidents in October and a decrease in the proportion of accidents in December.

Weather Condition

The team grouped accidents from both the JHIMDAT and the JHSAT according to whether the accident occurred in Visual Meteorological Conditions (VMC) or Instrument Meteorological Conditions (IMC). There was not a statistically significant difference in the proportion of VMC and IMC accidents between the two data sets.

Light Condition

The team grouped accidents from both data sets according to whether the accident occurred during the day or during the night. We categorized the following light conditions as night for purposes of the analysis: dawn, dusk, twilight, night bright, and night dark. There was not a statistically significant difference in the proportion of day and night accidents from the JHSAT to the JHIMDAT data.

Proportions of Fatal and Non-Fatal Accidents

The team selected several different data categories to analyze whether a statistical difference existed in the proportions of fatal versus non-fatal accidents in the JHIMDAT data as compared to the JHSAT data. For each data category selected, the team performed a separate chi squared analysis. The categories selected were:

- Accidents by Occurrence Category
- VMC Only Accidents
- IMC Only Accidents
- Accidents by Pilot's Make/Model Flight Hours

Regardless of the data category used for analysis, the conclusion was the same. The proportions of fatal versus non-fatal accidents in the JHIMDAT data were not statistically different when compared to the JHSAT data.

Accidents by Pilot's Flight Hours

The team analyzed accidents from the JHIMDAT data and the JHSAT data using two different types of pilot's flight hours: rotorcraft flight hours and make/model flight hours. A major limitation was associated with drawing conclusions related to the proportion of accidents as categorized by pilot's flight hours in a specific flight hour increment. The limitation was that the actual flight hours were unknown for the *non-accident* U.S. helicopter pilots.

Historical studies that pre-date IHST suggested the percentage of helicopter accidents associated with a specific increment of pilot's flight hours have a high positive correlation to the percentage of the total population of helicopter pilots (accident pilots and non-accident pilots) within each corresponding pilot's flight hour increment. If these past historical studies continue to be reliable, the following example illustrates the implications. It would be possible that if the percentage of accidents is twice as high for pilots with 0-500 hours rotorcraft hours as compared to pilots with 501-1,000 rotorcraft hours, the reason may be attributable to the total population of pilots with 0-500 rotorcraft hours being twice as large as the population of pilots with 501-1,000 rotorcraft hours. This conclusion is quite different than concluding lower flight hours alone (less flying experience) is the cause of why pilots with 0-500 rotorcraft hours have twice as many accidents as those in the 501-1,000 hour increment.

In the context of a comparative analysis such as this report, the same limitation applies. The underlying reason a specific pilot's flight hour increment may show a statistical difference in proportion of accidents between the JHIMDAT data and the JHSAT data may be because the flight hour increments for the total population of pilots may have changed. In summary, any conclusions related to an increase or decrease in the percentage of rotorcraft accidents associated with a specific pilot flight hour increment must include deliberation of the increases or decreases associated with the total population of pilots in that same flight hour increment.

Rotorcraft Flight Hours

The team analyzed the aggregate group of accidents from the JHIMDAT data by rotorcraft flight hour increments against the aggregate group of JHSAT data by rotorcraft flight hour increments. We used flight hour increments of 500 flight hours from 0 up to 7,500 flight hours (e.g. 0-500 hours, 501-1,000 hours, 1,001-1,500 hours, etc.). There were accidents where the pilot had greater than 7,500 rotorcraft flight hours. However, the number of pilots per each 500 hour increment above 7,500 rotorcraft flight hours was low. These cases could not be included in the analysis without sacrificing the accuracy of the statistical test. According to the chi squared analysis, there was not a statistically significant difference between the two data sets when comparing the accidents by rotorcraft flight hour increments.

Accidents with Pilot's Rotorcraft Flight Hours < or = 600 Hours

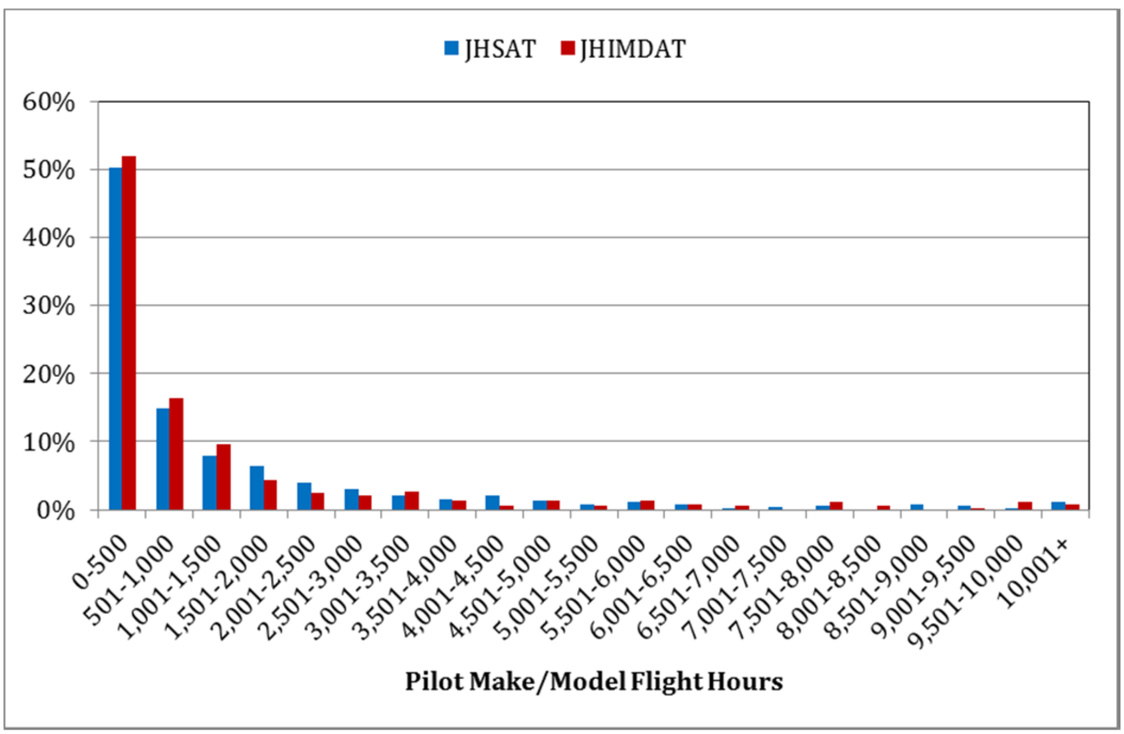
Cases where the pilot in the accident had less than or equal to 600 rotorcraft flight hours were organized by increments of 50 flight hours from 0 up to 600 flight hours (e.g. 0-50 hours, 51-100 hours, 101-150 hours, etc). The team's initial approach was to include all accidents where the pilot's rotorcraft flight hours were below 1,000 hours. However, the number of pilots per each 50 hour increment between 600 and 1,000 rotorcraft hours was low. These cases could not be included in the analysis without sacrificing the accuracy of the statistical test. According to the chi squared analysis, there was not a statistically significant difference between the two data sets when comparing accidents by rotorcraft flight hours for pilots with 600 hours or less.

Accidents by Pilot's Make/Model Flight Hours

The team analyzed the proportion of accidents categorized by pilot's make/model flight hours for both the JHIMDAT and JHSAT analyses. The analysis consisted of organizing the make/model flight hours by increments of 500 flight hours from 0 up to 4,500 flight hours. There were accidents where the pilots had greater than 4,500 make/model flight hours. However, the number of pilots per each 500 hour increment above 4,500 make/model flight hours was low. These cases could not be included in the analysis without sacrificing the accuracy of the statistical test. According to the chi squared analysis, there was not a statistically significant difference between the two data sets when comparing the accidents by make/model flight hour increments.

Figure 1 illustrates the distribution of pilots' make/model flight hours. The figure also includes the accidents where the pilot's make/model flight hours exceeded 4,500 flight hours that were excluded from the chi squared analysis. For purposes of consolidating the data in the figure, all cases where the pilot's make/model flight hours exceeded 10,000 flight hours were included in one category, shown in the table as "10,001+".

Figure 1. Distribution of Accidents - Pilots' Make/Model Flight Hours



*45 JHIMDAT accidents and 51 JHSAT accidents did not have pilot make/model time

Accidents with Pilot's Make/Model Flight Hours < or = 1,000 Hours

The team analyzed the proportion of accidents from both the JHIMDAT and JHSAT analyses for cases where the pilot in the accident had less than or equal to 1,000 make/model flight hours. The analysis consisted of organizing the make/model flight hours by increments of 50 flight hours from 0 up to 1,000 flight hours.

According to the chi squared analysis, the JHIMDAT data was statistically different from the JHSAT data. The flight hour increments where the number of accidents changed enough to be a major contributor to the statistical difference were:

Flight Hour Increment	Change
451-500 hours	Increased from 2.0% to 4.3% of accidents
651-700 hours	Increased from 1.6% to 3.6% of accidents
801-850 hours	Increased from 0.7% to 2.4% of accidents

Summary and Conclusions

In the comparative analysis of U.S. helicopter accidents from the JHIMDAT data (2009-2011) against the JHSAT data (2000, 2001, and 2006), the team observed that either stagnancy or regression was the most evident characteristic. The most frequently cited items were consistent between the data sets in many of the different analysis areas.

In the Industry analysis, the top five industries from Table 1 were the same and appeared in the same rank order from the JHSAT data to the JHIMDAT data: 1) Personal/Private, 2) Instructional/Training, 3) Aerial Application, 4) Emergency Medical Services, and 5) Commercial. These five industries accounted for about 70% of all U.S. accidents in the JHIMDAT data, so implementation measures must target more improvement in these industries to stimulate more significant accident reductions. Regrettably, the statistical analysis showed no significant difference between the proportions of accidents in four of the top five industries, an indication of stagnancy. The only Industry where the team noted a statistically significant difference was in Aerial Application, where regression occurred as evident by the significantly higher proportion of accidents.

The Industry/Activity pairs from Table 3 reinforced the observations about how a large volume of the accidents are disproportionately represented by a small number of industries. The three most frequently cited Industry/Activity pairs from the JHIMDAT analysis accounted for over 40% of the accidents from 2009-2011. Accidents from the Personal/Private Industry engaged in a Personal/Private Activity accounted for the highest percentage of accidents observed in the JHIMDAT data and showed a statistically significant increase in the proportion of accidents from the JHSAT data. The second and third most frequent Industry/Activity pairings in the JHIMDAT data were tied to the Instructional/Training and Aerial Application Industry sectors. Both of these pairings showed stagnancy in that there was no statistically significant change in the proportion of accidents observed in the JHIMDAT data when compared to the JHSAT data.

A separate but still perplexing problem in the Industry and Activity pairs is how frequently the Positioning/RTB Activity results in accidents for both the Emergency Medical Service and Aerial Application industries. Positioning/RTB involves moving the helicopter from one location to another and is not typically characterized by the same level of complexity as either of these Industry sectors would experience in executing the rest of their typical flight profile. Yet, Positioning/RTB was precisely the Activity that accounted for the highest number of accidents in each of these two Industry sectors.

In the Occurrence Category analysis from Table 4, the rank order for five out of the top six Occurrence Categories in the JHIMDAT data matched the JHSAT data and provided further evidence that the areas in need of the strongest implementation measures had not changed. Loss of Control continued to have the highest frequency of occurrence and also showed a statistically significant regression. One of the positive observations in the Occurrence Category analysis was that the System Component Failure category had a statistically significant improvement. The Sub-Occurrence Category analysis from Table 5 revealed this was attributable to a statistically significant improvement in the helicopter related System Component Failures (versus those that were engine related). Unfortunately, the rest of the most frequently cited Sub-Occurrence Categories showed either stagnation or regression.

The 21% reduction in the number of accidents that occurred in the three years covered by the JHIMDAT data (415 accidents) as compared to the three years in the JHSAT data (523 accidents) is progress and should not be disregarded nor minimized. However, the comparative analysis between the two data sets clearly showed that the areas responsible for the majority of U.S. helicopter accidents require more attention in order to achieve a more significant reduction in the overall number of accidents.

A key element missing from the comparative analysis between the data sets was clear answers to critical "Why" questions. For example, "Why is stagnancy and regression so prevalent in the analysis?" or "Why have implementation measures been less effective in these areas?" The origin of these questions is that we were uncertain as to what extent any of the tools and resources developed by the IHST had ever reached actual implementation with helicopter operators. The ambiguity left open several possibilities. Perhaps, some degree of implementation occurred yet did not produce any improvement. Unfortunately, there is also the possibility that implementation may never have occurred at all. There was no clear evidence for either of these two scenarios or any others, so this report chose not to speculate further. However, the prevalence of stagnancy and regression in the comparative analysis made it clear that the implementation measures for the highest accident producing Industry segments should be reevaluated. The USHST must either develop more rigorous implementation measures or formulate a more effective plan for ensuring that operators are actively using the implementation resources already available.

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