



Charged Warriors: An Analysis of Aircraft Battery Actions at FITA

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Abstract

This study examined the lifecycles of aircraft batteries in Florida Institute of Technology Aviation's (FITA) Piper Avidyne Warrior fleet. Many factors such as manufacturer specified useful life, optimum operational temperature, pilot energy management, and organizational factors all can affect the lifespans of lead acid batteries. An ex post facto design was used to examine battery actions per month from maintenance logbooks. Battery actions were considered to be either a recharge or an installation as recorded in the aircraft's airframe logbook. Both groups shared a similar distribution of total events by month. The fewest charges occurred in April, July, and December. A similar distribution was observed for battery installations. Months with peak installations occurred in March, June, and September. The fewest occurred in April, May, and December. An Analysis of Variance (ANOVA) and an eta squared effect size calculation were conducted for each battery action by month. There was no significant difference in frequency of battery charges and replacements by month and the effect sizes for both were very small.

Introduction

Batteries are a frequently replaced component in general aviation aircraft. The optimization of aircraft battery lifecycles at a facility operating many aircraft can become complex. Many factors such as useful life (Mibelli, 2016), optimum temperature (Tan, Feng, & Pecht, 2015), pilot energy management (Merkt, 2013), and organizational factors (Christensen & Dunn, 2011) all affect the lifespans of lead acid batteries.

Purpose and Research Question

The purpose of this study was to determine if there was a significant difference in frequency of aircraft battery installations and charges by month. Aircraft battery installation was defined as any battery installed in the Piper Avidyne Warrior logged in the aircraft's airframe logbook. Battery charge was defined as any recharge action logged in the same aircraft's airframe logbook.

Is there a difference in frequency of aircraft battery charges and installations by month among FITA's fleet of Piper Warriors?

Methods

1. This ex post facto study considered airframe maintenance logs for the Avidyne Warrior fleet at FITA. Data was gathered for the complete histories of these eight aircraft from 2008 to 2019.
2. Battery actions were recorded in an Excel spreadsheet for each aircraft in chronological order. Each entry included the aircraft registration number, the battery serial number, battery maintenance action, date, battery manufacturer and model number, aircraft total time in service, aircraft tachometer time, and pertinent notes.
3. Battery actions were tallied by month including months with zero actions. The frequency of each action was calculated per month to conduct descriptive statistics.
4. Two ANOVAs and effect size calculations were conducted in R Studio (one for recharges and one for installations).

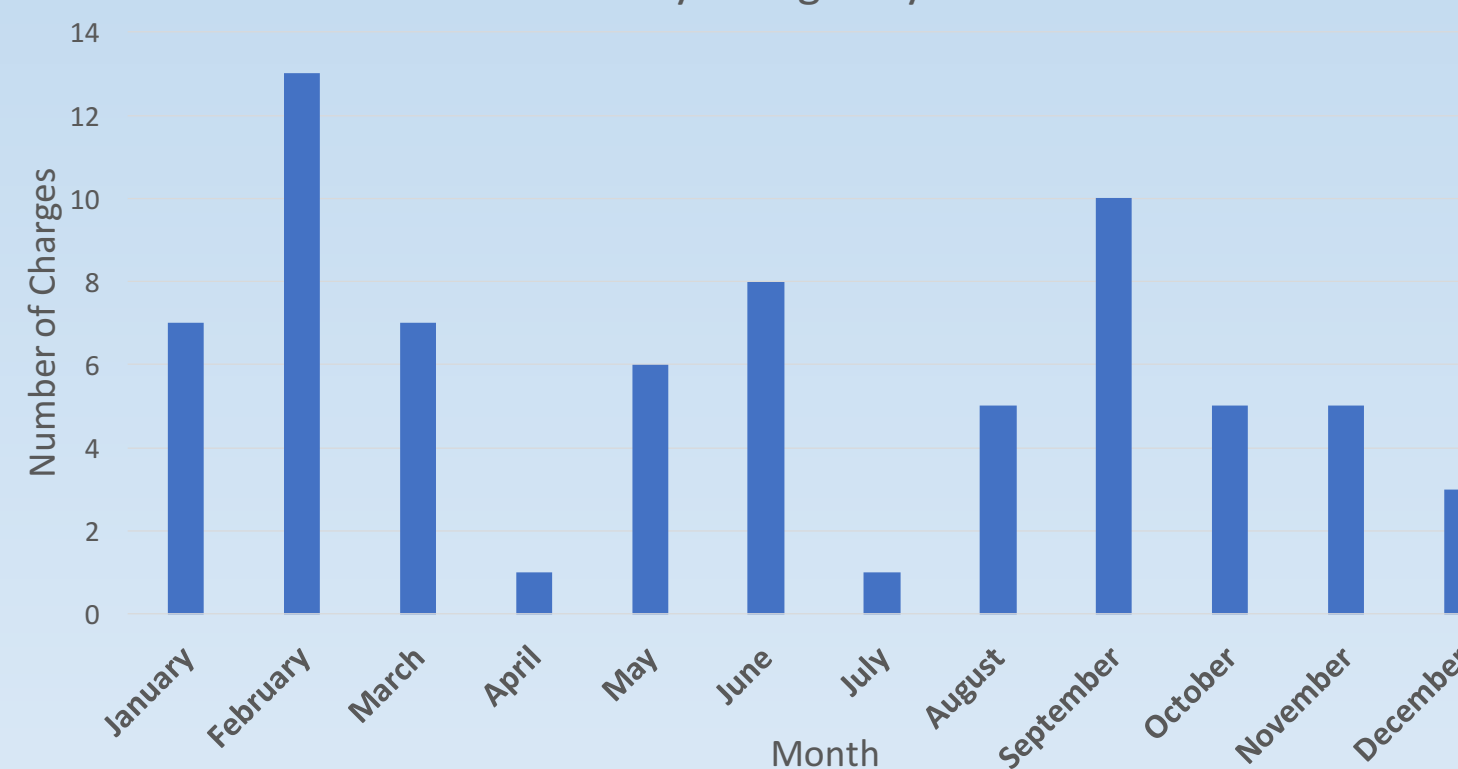
Results

The raw counts of actions per month indicated a roughly trimodal distribution for both battery actions. The number of charges per month peaked in February, June, and September. The fewest charges occurred in April, July, and December. A similar distribution was observed for battery installations. Months with peak installations occurred in March, June, and September. The fewest occurred in April, May, and December.

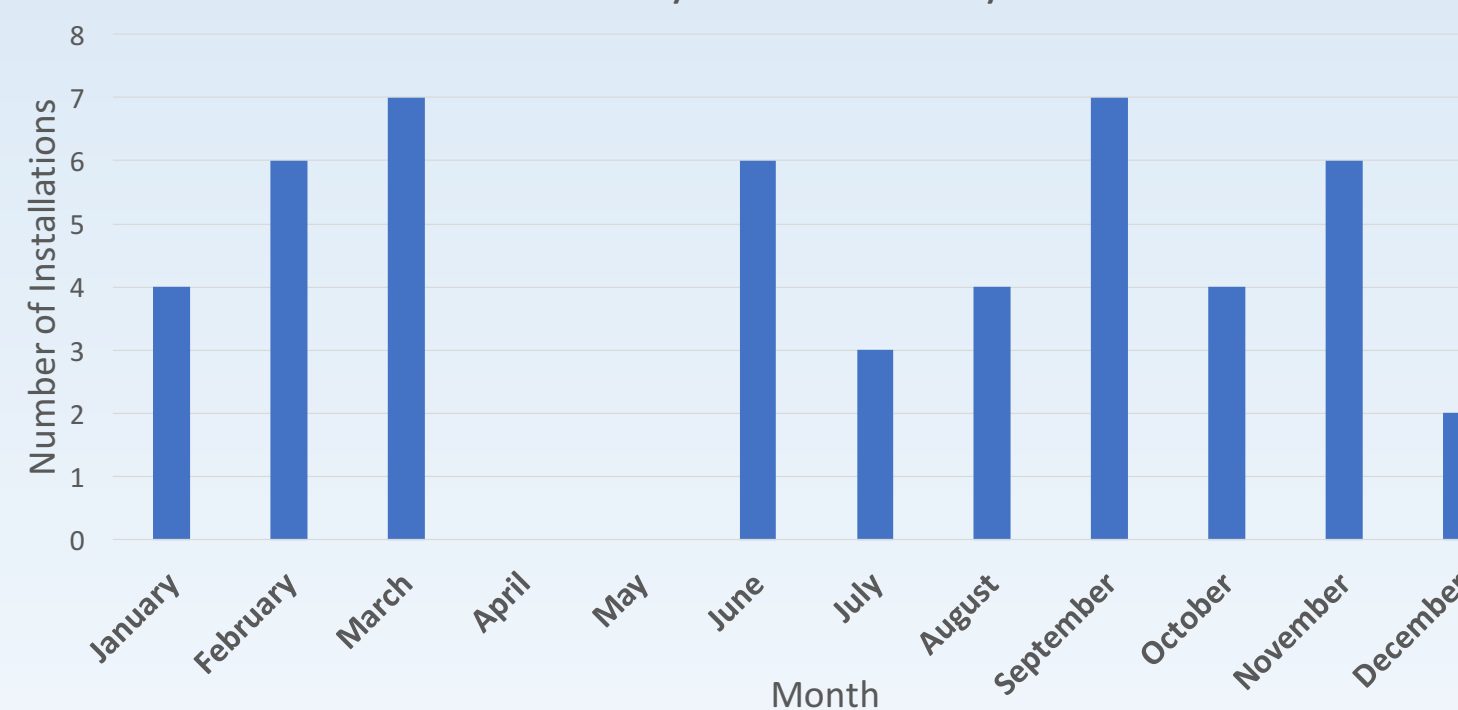
- The ANOVA for battery charges per month was not significant: $F(11, 106) = 0.951$, $p = 0.456$.
- The ANOVA for battery installations per month was not significant: $F(11, 106) = 0.995$, $p = 0.496$.
- The effect sizes were very small for both: $\eta^2 = 0.09$.

For both battery charges and battery installations per month, neither ANOVA indicated a significant difference in frequency of battery actions between months.

Aircraft Battery Charges by Month



Aircraft Battery Installations by Month



Discussion

Even though the differences in frequency between months were not significant for recharge and installation actions, it is crucial to note the similar pattern observed in both graphs depicting the number of actions per month since 2008.

The elevated count of actions in February and March could be attributed to engines struggling to start in colder weather. When aircraft starters labor to turn over, more battery voltage is used. A larger number of both battery actions occurred in September, possibly due to a greater number of student pilots conducting flight operations in the first full month of the Fall Semester. Fewer actions were counted over the summer, possibly due to a decrease in student pilot operations over the typical summer vacation months. The same situation was observed in December for both types of battery actions, perhaps due to a decrease in student pilot operations over winter break. Both operating temperature (Tan, Feng, & Pecht, 2015) and organizational factors (Christensen & Dunn, 2011) could play a large role in which months see the most battery actions. Maintenance facilities should prepare by ordering more replacement batteries for February, June, and September.

It is important to note different variants of the Gill G243 and the Concorde RG24 are used in FITA's Avidyne Warrior fleet. Verbal description from maintenance staff confirmed these batteries are similar in performance.

The results of this study are limited to the accuracy of logbook entries. Discrepancies in the maintenance logs could account for some error in the study. However, FITA logbooks are updated regularly and should be a reliable source for battery events.

Most battery installations were logged directly after multiple, consecutive, recharge actions, thus delaying flight operations. To be proactive, aircraft batteries should not be expected to recharge to their originally specified peak voltages.

Future Research

Since both Gill and Concorde batteries are used at FITA, this study prompts further research of different brands of aircraft batteries. In addition, conducting further research with other types of aircraft would reinforce the results of this study because other aircraft have different technical specifications which could incorporate other variables. Collaboration with other maintenance facilities, particularly in colder climates, would be a feasible next step to expand on this study.

References

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