Analysis of the Effect of Carbon Monoxide Exposure on Accidents/Incidents in General Aviation Aircraft

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Abstract. Exposure to carbon monoxide (CO) can cause harmful health effects depending on its concentration and duration of exposure. Exhaust system failures in general aviation (GA) aircraft can result in CO exposure which, in turn, can lead to an accident. This research was performed in order to obtain insight into the causes of CO-related accidents/incidents in GA aircrafts through the analysis of historical data from the NTSB accident/incident database. The results indicated that CO related accidents/incidents occur throughout the year and that the muffler was the most common source of CO leakage. This was found to be the case even though accidents due to muffler and exhaust system leakage were more prevalent in the colder months. This paper reviews the data and presents the results of the analysis.

1. Introduction and Background

Carbon monoxide (CO) is a byproduct of the combustion of fuel and is emitted in the exhaust of fuel powered equipment and engines. CO is formed by the incomplete combustion of carbon-containing materials, which are present in aviation fuels. Carbon monoxide is a hidden danger because it is a colorless and odorless gas. Exposure to CO can cause harmful health effects depending on the concentration and duration of exposure. Acute CO poisoning is associated with headache, dizziness, fatigue, nausea, and at elevated doses, neurological damage and death. Exposure to CO can result in individuals becoming confused or incapacitated before being able to leave the contaminated environment. When this occurs in an aircraft, the end result could quite possibly be an accident. In order to provide cabin heat, a heat exchanger is usually attached to the exhaust system of single engine aircraft. A crack or damage in this part can highly increase the possibility of CO exposure in the cabin. According to one FAA report [1], 70% of exhaust system failures resulted in a CO hazard. Thus, proper inspection and maintenance of the exhaust system is extremely important.

2. NTSB Accident/Incident Database Review

Of the 68,640 cases in the National Transportation Safety Board (NTSB) accident/incident database [2] between 1962 and 2005, 67 cases were directly related to CO exposure. Our review of the NTSB database classified the accident, whenever possible, according to source of the CO leak such as muffler, heater system, or exhaust system. The largest group of 27 cases remained undetermined due to lack of information.

The cases were divided by the source of the CO leak so that the majority group would become the focus of further research. When these cases were divided up, as shown in Figure 1-Left, it was clear that mufflers were the top source of CO. The muffler cases were then isolated and examined for similarities. A Piper PA-28 manual [3] recommended that the muffler be replaced with a new one every 1000 hours of use. When accident cases specifying the muffler as the source of CO were grouped according to flight hours (Figure 1-Right), and where the accident narrative indicated the hours the muffler had been in use, all of the CO-related accident cases that were related to the muffler had exceeded 1000 hours of use. Additionally, more than 70 percent of the cases had a muffler life of over 2000 hours of use.

These cases were divided into seasons with December, January, and February as the winter months; March, April, and May as spring; June, July, and August as summer; September, October, and November as fall. Then each season was subdivided by source of CO leakage as shown in Figure 2-Left. It was observed that muffler and heater system cases were more prevalent in the colder seasons such as the fall, winter, and spring (Figure 2-Left). It was also observed that most of the cases in the summer were of undetermined causes (Figure 2-Left), but roughly the same number of CO-related accidents/incidents occurred in every season.
For most cases after 1990, the NTSB database included longer narratives including forms containing maintenance and inspection information. These full narratives typically classified the cases under the terms “inadequate maintenance and inspection”, “poor inspection”, “missed inspection”, or “poor maintenance”. The cases that did mention a maintenance/inspection classification were then cross-referenced and divided according to the source of CO leakage (Figure 2-Right). From the chart in Figure 2-Right it is apparent that all the poor inspection cases had the muffler as the source of CO. This makes sense because the muffler is the most complex part to inspect.

Figure 1 - CO-related accidents based on source of CO leakage (Left) and hours of muffler use before CO-related accidents (Right).

3. Conclusions

The review of the NTSB accident/incident database indicates that CO-related accidents due to muffler and exhaust system leakage were more prevalent in the colder months. However, CO accidents do occur throughout the year including the summer months. Additionally, “inadequate maintenance and inspection” were implicated with a large proportion of the CO-related accidents. The NTSB accident/incident data supports the known difficulty of inspecting mufflers and the joints in the exhaust system. Finally, the review of the NTSB accident/incident database indicates a strong relationship between the lifespan of mufflers and their failure, where a large majority of the mufflers that were determined to be the cause of the CO-exposure had muffler usage greater than 1000 hours.

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References