Assessing Transport Aircraft Inspection Strategies

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ABSTRACT

Complex aircraft require periodic maintenance checks to assess needed repairs for continued vehicle availability. However, such checks are expensive and the associated aircraft downtime can reduce fleet mission effectiveness. The United States Air Force plans to consolidate the time-based (isochronal) C-5 aircraft major inspection activities for eight C-5 home stations into three locations. Isochronal inspections rely on a calendar method to schedule inspections and disregard actual flying hours between inspections. By having the same personnel perform these inspections for all flying units and by adopting commercial aircraft condition-based inspection strategies, the Air Force hopes to gain efficiencies in performing these inspections. Conversely, the site phase-out schedule and reduced number of inspection locations raises questions about whether overall C-5 mission capability will be reduced. These proposed revisions were simulated in a designed experiment to assess the impacts to fleet availability and inspection site workload.

Keywords: Aircraft Inspection, Decision Models, Maintenance, Planning Models, Research Methodology, Simulation

INTRODUCTION

Scheduled maintenance is crucial to preserving high aircraft reliability levels. The U.S. Federal Aviation Administration sued Southwest Airlines for over $10 million in 2008, alleging that the airline failed to perform mandatory periodic safety checks and thus flew unsafe aircraft (Griffith & Bronstein, 2008). These mandatory periodic checks—performed by both the commercial sector and the military—are preventative measures designed to reduce the chances of aircraft component failures (Boller, 2001; Bowen, 1996; Kozanidis et al., 2008; Lambert & Troughton, 1967). However, because such inspections are expensive, aircraft maintenance practices are migrating toward condition-based strategies and centralized maintenance processes to preserve aircraft readiness at lower cost (Bolinger, 2007; Durand, 2008; Gellar et al., 2005; Kapoor et al., 2004; Swift, 2008; Wu et al., 2004).

In this paper, we discuss our research to estimate potential improvements the United
States Air Force may achieve by changing C-5 transport aircraft inspection processes. The C-5 Galaxy, one of the largest aircraft in the world, provides a strategic airlift capability for the United States Air Force and supports many defense and humanitarian objectives, and thus efforts to increase its operational availability are important. Availability is the percentage of time that an aircraft is deemed as flight-capable; hence aircraft downtime resulting from maintenance or inspections reduces availability and thus decreases overall operational availability.

The Air Force is planning on implementing three important initiatives simultaneously: consolidating existing aircraft inspection sites, using new inspection site-aircraft assignment selection methods, and adopting new aircraft inspection procedures—all in the hope of sustaining C-5 availability levels at less cost. Our simulation modeling and analyses of these initiatives can help the Air Force understand how to best achieve these desired outcomes. Because of the strong similarity between commercial and military aviation maintenance processes, our research method and results are applicable to any aircraft maintenance organization seeking ways to preserve aircraft readiness at lower cost.

This paper is organized as follows: The next section surveys the relevant background and literature. The specific research problem and the methodology employed is also described. We then follow with our analysis. We conclude with recommendations for specific Air Force actions, a note on the study’s limitations, and suggestions for future research.

Background

Although the terminology is different, inspection processes used in civil aviation closely parallel those applied to military aircraft. Before each flight, “walk-around” checks of commercial aircraft are routinely conducted to detect leaks or obvious damage. An A-check is performed approximately weekly and consists of operational checkouts, fluid servicing, and visual inspections. B-checks are conducted every 3-4 months, and include both A-check activities and preventive maintenance inspections such as spectral analysis of engine fluids, filter checks, and parts lubrication. C-checks—detailed inspections of airframe, engines, and accessories—are conducted every 15-16 months. Finally, D-checks are the most extensive type of inspection and are designed to restore the aircraft to as “new” a condition as is deemed practical (Dixon, 2006; Sriram & Haghani, 2003).

Military C-5 inspection practices also include daily walk-around checks. Home station checks—like B-checks—are performed every four months. Our research focuses on the Air Force isochronal maintenance (ISO) inspection process, which is roughly equivalent to the civilian C-check. A C-5 ISO consists of a series of actions that collectively provide a thorough inspection of all aircraft subsystems. An ISO is conducted in an area termed a “dock” traditionally located at the flying unit’s home station. Repair actions are initiated if any discrepancies are found. Delayed discrepancies—degradations that were previously deferred for repair—may also be corrected during this inspection. ISOs are performed in a hierarchical manner. The “minor” inspections are systems reliability checks and are performed every 14 months. A “major” inspection follows one or more minor inspections and combines minor inspection activities with an assessment of selected aircraft structures. More minor inspections follow, and the cycle culminates with depot maintenance. Programmed depot maintenance activities—like their civilian D-check counterparts—involve complete aircraft disassembly at a single, specialized facility where workers conduct a detailed investigation of aircraft structural integrity and restore the aircraft to “as new” condition.

The typical C-5 ISO process begins with an aircraft wash, followed by the inspection. This process then routes aircraft to a fuel cell and concludes by performing backline maintenance. The inspection area is an aircraft hangar with custom-designed maintenance stands to facilitate maintenance in normally inaccessible areas of the aircraft including engines, mounting
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