

2019

# The Role of Stakeholders After Development of the Baseline Scheduled Maintenance Program

Danita Baghdasarin

Boeing, baghdasd@my.erau.edu

Follow this and additional works at: <https://commons.erau.edu/ijaaa>



Part of the [Other Engineering Commons](#)

---

## Scholarly Commons Citation

Baghdasarin, D. (2019). The Role of Stakeholders After Development of the Baseline Scheduled Maintenance Program. *International Journal of Aviation, Aeronautics, and Aerospace*, 6(4). Retrieved from <https://commons.erau.edu/ijaaa/vol6/iss4/16>

This Position Paper is brought to you for free and open access by the Journals at Scholarly Commons. It has been accepted for inclusion in International Journal of Aviation, Aeronautics, and Aerospace by an authorized administrator of Scholarly Commons. For more information, please contact [commons@erau.edu](mailto:commons@erau.edu), [wolfe309@erau.edu](mailto:wolfe309@erau.edu).

---

# The Role of Stakeholders After Development of the Baseline Scheduled Maintenance Program

## **Cover Page Footnote**

A sincere and heartfelt thanks to Maciej Razniewski for significant technical contributions and for continuous and unwavering mentorship.

## **Introduction**

The Part 119 Air Carriers and Commercial Operators' maintenance programs have three primary objectives, per Advisory Circular (AC) 120-16G. All aircraft must be maintained and released to service in an airworthy condition, and maintenance must be performed by qualified personnel, with adequate equipment in adequate facilities, and in accordance with instructions contained in the General Maintenance Manual (GMM) (Federal Aviation Administration, 2016). Air Carriers and commercial operators can assure the continued airworthiness of their fleets by performing scheduled maintenance. Today, the scheduled maintenance program is developed through collaboration between the Federal Aviation Administration (FAA) and foreign regulatory authorities, original equipment manufacturers (OEMs), and operators, which together form the Industry Steering Committee (ISC) (Federal Aviation Administration, 2012). This program is developed following the aircraft system or structure analysis, task determination, and interval selection procedures established by the original 1980 Maintenance Steering Group – 3<sup>rd</sup> Task Force (MSG-3) and its later revisions.

From a systems engineering perspective, the aircraft maintenance program is a complex adaptive system of systems; systems, structures, zonal, and lightning/high-intensity radiated fields subject matter experts create the respective subsections of the Maintenance Review Board Report (MRBR) in accordance with MSG-3 methodology, but do not necessarily know how the overall program

will perform. The ISC represents the stakeholders, and it is through ISC approval that changes are made to the system and the system is optimized (Federal Aviation Administration, 2012). The baseline scheduled maintenance program is created early in the airplane development program as a collaborative effort of the ISC, whose members are considered equal constituents; the baseline scheduled maintenance program cannot be developed without any one member. The role stakeholders also play in system sustainment can be fully appreciated through examination of the result of decisions made without them. In the context of the scheduled maintenance program, what value does the ISC add throughout the airplane life cycle? How involved do the regulatory authorities, OEMs, and operators really need to be?

### **Failures to Communicate**

#### **Aloha Airlines Flight 243**

The Boeing 737-200 was pre-flighted by the first officer in the early morning, before several inter-island flights, of April 28, 1988 (Federal Aviation Administration, n.d.). The pre-flight inspection did not result in any findings, and Aloha Airlines did not require additional inspections between flights (Federal Aviation Administration, n.d.). On an afternoon leg from Hilo to Honolulu, when the aircraft had reached 24,000 feet, it was subjected to an explosive decompression event (Federal Aviation Administration, n.d.). A large portion of

the upper fuselage separated from the aircraft; there were eight serious injuries and one fatality (Federal Aviation Administration, n.d.).

Investigations would later reveal that Aloha Airlines' heavy maintenance check ("D-check") was performed at 15,000 flight hours, which was earlier than Boeing's recommended interval of 20,000 flight hours (Federal Aviation Administration, n.d.). However, Aloha Airlines' schedule and routes resulted in a much quicker accumulation of flight cycles than experienced by the average fleet, resulting in earlier fatigue damage and crack potential (Federal Aviation Administration, n.d.). Additionally, the D-check was broken down into 52 overnight light maintenance checks ("B-checks") (Federal Aviation Administration, n.d.). These B-checks prevented maintenance personnel from being able to assess the aircraft's overall condition (Federal Aviation Administration, n.d.). Furthermore, indications of corrosion onset were determined to be normal wear and tear (Federal Aviation Administration, 1993). Aloha Airlines did not seem to have a corrosion program in place, and remedial actions were deferred without justification (Federal Aviation Administration, 1993).

This case study is one of the most referenced maintenance-related accidents. The FAA (n.d.) stated that Aloha Airlines' flight cycle accumulation rate was not adequately addressed by Aloha Airlines when the airline's scheduled maintenance program was developed and approved by the FAA. This includes

both the decision to perform the D-check at 15,000 flight hours, and the decision to break it down into numerous B-checks. The ISC provides a forum for operators to share information about their operations and preferences for maintenance intervals. An operator such as Aloha Airlines would have the ability to spotlight an issue like rapid flight cycle accumulation, and with the support of other airlines and approval of the regulatory authorities, shape the manufacturer's recommended maintenance program, intervals included. Conversations about and comparison of corrosion accumulation with other operators may have prompted the airline to take more immediate measures to address corrosion. Unfortunately, it took this accident to prompt the creation of the Corrosion Prevention and Control Program (CPCP), an element of the scheduled maintenance program which is supported by regulatory authorities, OEMs, and operators to this day (Federal Aviation Administration, 1993).

### **Partnair Flight 394**

Partnair Flight 394 was a Convair CV-340/580 performing a charter flight from Oslo, Norway to Hamburg, Germany on September 8, 1989. An air traffic controller in Copenhagen spotted the aircraft making an unexpected turn and disappearing from radar. Search and rescue efforts began when the flight crew failed to respond to radio calls; the aircraft wreckage was eventually found scattered at sea and all five crew members and 50 passengers considered fatally injured (The Aircraft Accident Investigation Board Norway, 1993).

The aircraft's fixed and control tail surfaces exhibited signs of abnormal wear and tear, said to be improperly repaired during the last overhaul and worsened by the vibration of the auxiliary power unit (APU), which had a defective front support that did not meet the manufacturer's design specifications. The investigation also found that aircraft ownership had transferred at least 10 times since 1953, and the latest maintenance instructions were incomplete and did not match aircraft configuration. Specifically, procedures pertaining to the APU front support were outdated and erroneous (The Aircraft Accident Investigation Board Norway, 1993).

Among the recommendations made by The Aircraft Accident Investigation Board Norway (AAIB/N) were calls for increased oversight, particularly of "aircraft requiring special attention" (The Aircraft Accident Investigation Board Norway, 1993, p. 114). This recommendation included a call for regulatory authorities to introduce mandatory quality assurance (The Aircraft Accident Investigation Board Norway, 1993). Today, regulatory authorities and their delegates are highly involved in maintenance oversight and have the final approval authority over scheduled maintenance programs and repairs.

### **Nigeria Airways Flight 2120**

Nigerian Airways' McDonnell Douglas DC-8 experienced failure of the left main gear tires and wheels during takeoff from King Abdulaziz International Airport in Jeddah, Saudi Arabia on July 11, 1991. The burning tires retracted with

the landing gear, causing a fire to build in the left main wheel well. The fire led to depressurization and loss of control in addition to destroying the hydraulic system and airframe. The crew tried to initiate an emergency landing, but the aircraft crashed and killed all 14 crew members and 247 passengers on board (Flight Safety Foundation, 1993).

Maintenance was found to be a contributing factor in this event as well. The aircraft was found to be in an unworthy condition; tire pressure was lower than the allowable dispatch pressure and had not been checked for several days, but the aircraft was signed off as airworthy (Flight Safety Foundation, 1993). Interestingly, the investigation report did not include recommendations for the maintenance causal factor. The safety-criticality of adequate tire servicing was perhaps not well understood by the airline or otherwise communicated by the manufacturer, and this event serves as an example of lack of oversight of scheduled maintenance that could result in safety hazards.

### **Chalk's Ocean Airways Flight 101**

Chalk's Ocean Airways Flight 101 was a Grumman Turbo Mallard (G-73T) en route from the Miami Seaplane Base to Bimini, Bahamas on December 19, 2005. The aircraft crashed into a shipping channel off the Port of Miami after the right wing departed in flight, killing all 20 passengers (National Transportation Safety Board, 2007).



Upon investigation, it was revealed that the right rear Z-stringer had likely been fractured for years prior to the accident, and this fatigue damage was followed by fatigue cracking in the skin, propagating from corrosion at the fuel sump drain. The accident report commented on Chalk's Ocean Airways' maintenance program and its inability to address structural problems; while maintenance personnel were able to identify and repair structural issues, those repairs did not restore the aircraft to an airworthy condition. Investigation also identified corrosion throughout the structure and other cracks which would have eventually led to an event had this particular accident not occurred (National Transportation Safety Board, 2007).

Chalk's Ocean Airways seemed to have had two big issues: its maintenance program failed at addressing the fatigue and corrosion damage accumulated by the accident aircraft over time, and organizational culture pressured the maintenance department to dispatch aircraft regardless of their airworthiness status. This was not helped by the lack of Principle Maintenance Inspector (PMI) oversight; a review of paperwork signed by the PMI indicated that a major repair to the Z-stringer was undocumented (National Transportation Safety Board, 2007). Both the airline and the FAA representative could have been more diligent in inspecting the aircraft, documenting findings, and speaking up when signs of aircraft aging were noted. Findings that could have been noted by

both parties had the maintenance program been more robust could have been presented at the industry level and a maintenance optimization activity proposed.

### **Discussion**

Stakeholders are critical to the success of a system at all stages in the system's life cycle. In the problem definition stage, stakeholders provide information that defines the scope of the problem and the parameters within which the solution must fit (Parnell, Driscoll, & Henderson, 2011). In the context of the baseline scheduled maintenance program, the members of the ISC collaborate to identify system characteristics that lead to the development of scheduled maintenance, discuss whether recommended maintenance is feasible, and determine whether the recommended tasks and intervals satisfy system and user requirements. This interaction continues to solution implementation, during which stakeholders act on the tasks and controls of the solution. For the ISC, this entails the regulatory authorities' approval and oversight of the scheduled maintenance program, the OEMs' production and maintenance of the scheduled maintenance program, and the operators' implementation of and feedback concerning the scheduled maintenance program.

The longest and most prominent stage of a system's life cycle is often system operation, and this is certainly true when it comes to the aircraft scheduled maintenance program. During this stage, stakeholders have several objectives, including monitoring and evaluating system performance to plan, identifying

operational risks, and looking for opportunities to optimize system performance in order to give the user a competitive advantage (Parnell et al., 2011). In this case, the monitoring and evaluating of the scheduled maintenance program is done for the global fleet by the OEM, and for individual fleets by operators. Through monitoring and evaluating, these stakeholders can identify opportunities to statistically optimize the scheduled maintenance program at the different levels. Both of these parties must be aware of and openly communicate any safety, operational, and economic risks inherent in the system, and the regulatory authorities must speak up when a safety risk exists. Thus, the constant communication and participation of the members of the ISC ensure system success long after the system solution, in the form of the baseline scheduled maintenance program, is implemented.

Each of the accidents previously discussed illustrates the value each member of the ISC adds to the airplane life cycle by highlighting what happens when the member is not involved. In the Aloha Airlines example, communication between the OEM and operator should have revealed concerns about flight cycle accumulation and the issues resulting from re-packaging the heavy check and collaboration between operators with varying experience would have revealed more about the seriousness of corrosion experienced by Aloha Airlines. The Partnair and Nigeria Airways examples emphasize the importance of regulatory oversight over airworthiness. Finally, the Chalk's Ocean Airways accident is an

example where all three parties could have been more involved. The three members of the ISC balance each other out, holding each other accountable for their individual roles in system development, implementation, and operation. Through thorough and continuing discussion, these stakeholders can ensure the system requirements, plan, risks, and outcomes are understood, and labor toward ensuring the system operates at the highest possible level of safety.

### **Conclusions and Recommendations**

Parnell et al. (2011) explained the important role systems play in society, emphasizing that effective systems provide value to consumers and owners, whereas ineffective systems can be detrimental financially and physically. To assure the success of a system, stakeholders may opt to employ systems engineering best practices, from general systems thinking to detailed solution implementation strategies. Systems engineering tools and resources contribute to the development and sustainment of effective systems by:

- Bringing together expertise from various applicable disciplines and perspectives,
- Accounting for the system's entire life cycle,
- Facilitating brainstorming of mutually beneficial solution designs, and
- Using modeling and simulation to narrow down solution design options (Parnell et al., 2011).

Therefore, it is appropriate to consider the individual members of the ISC systems engineers, and the aircraft scheduled maintenance program the system they produce and improve. Each member brings with him or her some unique knowledge of aircraft systems, maintenance operations, regulatory requirements, and aviation safety. The ISC also provides a forum for inexperienced and experienced members to collaborate, increasing the overall conglomerate's knowledge of the system's life cycle (i.e. task selection, task evolution, and task retirement). In early stages of the system life cycle, the OEM will likely propose changes to the system for consideration by operators and regulatory authorities. However, later in the life cycle, the operators and regulatory authorities may propose changes as well, in the form of a request for task optimization, airworthiness directive, or Issue Paper. In many cases, cost-benefit models are helpful in finalizing changes to the system. Will a task be economical? Is there an operational impact on the airline if a task is not required? Does performing a task ensure operational safety?

In some cases, the answers to these questions are not obvious to any singular member of the ISC. For instance, a failure-finding maintenance task may be seen as applicable and effective by the OEM, but economically burdensome by the operator. If whether or not a task is required has no bearing on operating safety, the ISC may decide no task is necessary at all. The importance of this relationship and communication between regulatory authorities, OEM, and

operators cannot be stressed enough. As evidenced by the aviation events discussed herein, lapses in communication and collaboration have led to what Parnell et al. (2011) would consider ineffective systems. However, continuous involvement of these stakeholders in the systems engineering life cycle can help contribute to more effective systems that benefit everyone.

## References

- The Aircraft Accident Investigation Board / Norway. (1993). *Report on the Convair 340/580 LN-PAA aircraft accident north of Hirtshals, Denmark, on September 8, 1989*. Retrieved from <https://www.aibn.no/aviation/reports/1993-02-eng>
- Federal Aviation Administration. (n.d.). *Aloha Airlines flight 243, Boeing 737-200, N73711*. Retrieved from [https://lessonslearned.faa.gov/ll\\_main.cfm?TabID=4&LLID=20&LLTypeID=0](https://lessonslearned.faa.gov/ll_main.cfm?TabID=4&LLID=20&LLTypeID=0)
- Federal Aviation Administration. (2012). *Advisory circular 121-22C: Maintenance review boards, maintenance type boards, and OEM/TCH recommended maintenance procedures*. Retrieved from [https://www.faa.gov/documentLibrary/media/Advisory\\_Circular/AC%20121-22C.pdf](https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%20121-22C.pdf)
- Federal Aviation Administration. (2016). *Advisory circular 120-16G: Air carrier maintenance programs*. Retrieved from [https://www.faa.gov/documentLibrary/media/Advisory\\_Circular/AC\\_120-16G.pdf](https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_120-16G.pdf)
- Federal Aviation Administration (1993). *Order 8300.12: Corrosion prevention and control programs*. Retrieved from <https://www.faa.gov/documentLibrary/media/Order/8300.12.pdf>
- Flight Safety Foundation. (1993). *Tire failure on takeoff sets stage for fatal inflight fire and crash*. *Flight Safety Foundation Accident Prevention*,

50(9). Retrieved from <https://web.archive.org/web/20180712130132/>

[https://flightsafety.org/ap/ap\\_sep93.pdf](https://flightsafety.org/ap/ap_sep93.pdf)

National Transportation Safety Board. (2007). *Aircraft accident report: In-flight separation of right wing, Flying Boat, Inc. (doing business as Chalk's Ocean Airways) Flight 101, Grumman Turbo Mallard (G-73T), N2969, Port of Miami, Florida, December 19, 2005*. Retrieved from <https://www.nts.gov/investigations/AccidentReports/Reports/AAR0704.pdf>

Parnell, G. S., Driscoll, P. J., & Henderson, D.L. (2011). *Decision making in systems engineering and management*. Hoboken, NJ: Wiley.