



Interagency Aviation Accident Prevention Bulletin



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Subject: Human Factors in Aviation Maintenance

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Discussion: What's it take to get an aircraft off the ground? Simple question right? Well, if you initially said a pilot, you answered wrong. The correct answer is an aircraft mechanic. That's right. It's an easy mistake to make since we often focus on pilots and aircrew when we look at aviation operations. But let's face it, without aircraft mechanics, there wouldn't be any airworthy aircraft for pilots to fly. Think about it.

Since the end of World War II, human factors researchers have studied pilots and the tasks they perform. Yet until recently, maintenance personnel were overlooked by the human factors researchers. Whatever the reason, it's not because maintenance is insignificant. Maintenance is one of the largest costs associated with aircraft operations. Most importantly, maintenance errors can have grave implications for flight safety.

Maintenance personnel are confronted with a set of human factors unique within aviation. Maintenance technicians work in an environment that is more hazardous than most other jobs in the labor force. Their work may be carried out at heights, in confined spaces, in numbing cold or sweltering heat. Their work can also be physically demanding, yet it requires clerical skills and attention to detail. Maintenance personnel also face unique sources of stress. When maintenance personnel leave work at the end of their shift, they know that the work they performed will be relied on by crew and passengers for months or years into the future.

Maintenance errors can be the most visible result of maintenance human factors, but to understand how and why maintenance errors occur, we need to understand the organizational context in which they occur. Figure 1 below shows the main causal elements involved in accidents and incidents. It is an adaptation of the 'Swiss Cheese' model originally developed by James Reason (see DOI Lessons Learned 09-02). According to this model, accidents or incidents are usually triggered by the actions of operational personnel, such as pilots or maintenance engineers. However, these actions occur in the context of local conditions, such as communication, workplace conditions, and equipment. The task environment also includes risk controls. Risk controls are features such as procedures, checks or precautions designed to manage hazards that threaten safety. Risk controls, local conditions and individual actions can, in turn, be influenced by organizational factors such as company policies, resource allocation, and management decisions.

In order to understand and ultimately prevent accidents, it's necessary to trace the chain of contributing factors back through all the elements of the system including organizational influences. This is often referred to as root cause analysis.

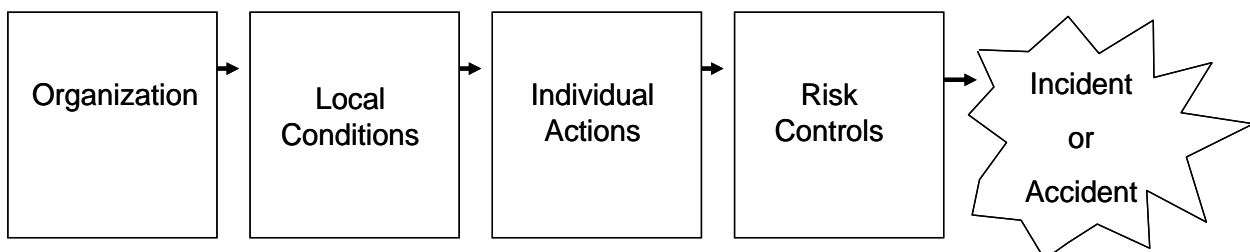


Figure 1

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The individual actions that lead to maintenance incidents often reflect local conditions present in the workplace at the time of the action. Such conditions include: time pressure, fatigue, equipment deficiencies, teamwork, and group norms. Accurately identifying the nature of an error and the local conditions that prompted it is a critical step toward identifying how the system can be improved to prevent the problem from occurring again.

Originally referred to as ‘defenses’ by James Reason, risk controls are features put in place to manage hazards in the workplace. There are two main types of risk controls related to maintenance error – preventative risk controls and recovery risk controls.

Preventative risk controls are intended to reduce the chance of unwanted events such as human error. Examples of preventative risk controls are training, task qualifications, or components designed to prevent incorrect installation.

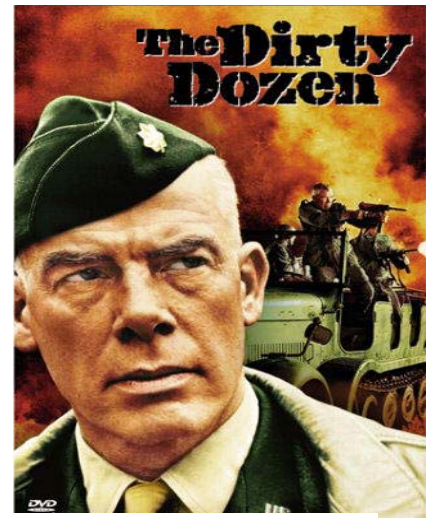
Recovery risk controls are designed to detect and recover from a dangerous situation once it has started to develop. Functional checks and duplicate inspections are examples of procedures designed to detect maintenance errors.

Although maintenance occurrences usually involve errors made by technicians, investigations of aviation maintenance events also identify organizational-level factors such as: training and qualification systems; the allocation of resources; and the cultural or value systems that permeate the organization. Although they are unwanted events, errors are valuable opportunities to identify needed improvements and implement changes.

The organizational response to maintenance error requires two approaches. First, the probability of maintenance error can be minimized by identifying and counteracting error-producing conditions within the organization. This typically involves attention to fatigue management, human factors training, the provision of appropriate tooling and equipment, and other actions directed at human factors associated with maintenance error. Second, it must be acknowledged that maintenance error is a threat that can be reduced, but never entirely eliminated. One must remain ever vigilant. Organizational resilience in the face of human error can be maximized by ensuring that appropriate risk controls are in place to identify and correct errors, and minimize the consequences of those errors that remain undetected.

The “Dirty Dozen” are twelve most common maintenance-related causes of errors, according to the FAA (AC 120-72). The Dirty Dozen includes:

1. Lack of Communication.
2. Complacency
3. Lack of Knowledge
4. Distraction
5. Lack of Teamwork
6. Fatigue
7. Lack of Resources
8. Pressure or sense of urgency
9. Lack of Assertiveness
10. Stress
11. Lack of Awareness
12. Social or Organizational Norms

**References:**

1. FAA AC 120-72, *Maintenance Resource Management Training*
2. *An Overview of Human Factors in Aviation Maintenance*, Australian Transport Safety Bureau, Aviation Research and Analysis Report 2008-055, Alan Hobbs Ph.D., December 2008

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