Operator's Manual for Human Factors in Maintenance and Ground Operations

U.S. Department of Transportation
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Flight Standards Service
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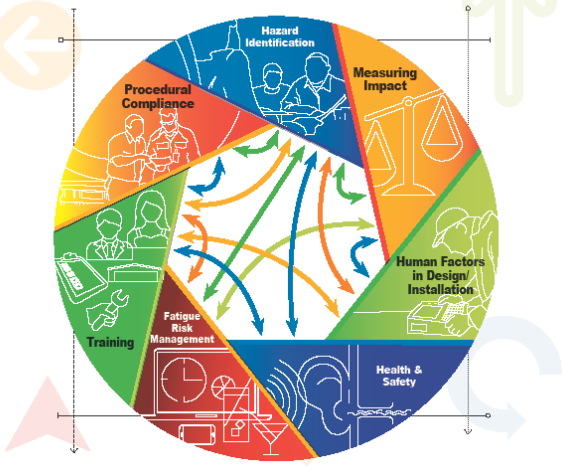

INTRODUCTION

This manual recognizes that readers already know the importance of human factors — a science that pays attention to physical, psychological, and other human attributes to ensure that we work safely and efficiently with minimal risk to others and equipment. The chapters discuss seven critical human factors topics that contribute to the goal of creating and reinforcing a safety culture where employees practice safe habits, both at work and at home.

Seven Human Factors Topics

- Hazard Identification
- Procedural Compliance and Documentation
- Human Factors Training – Evolution and Reinforcement
- Fatigue Risk Management
- Human Factors Health and Safety Program
- Considering Human Factors Issues in Design and Installation
- Measuring Impact and Return on Investment (ROI)

The references, by design, are few and limited to those providing the most relevant information. Chapters have identical format and include:

1. Chapter topic introduction
2. Why the topic is important
3. How to implement the program component
4. How to know the program component works
5. Key references and links

Operational data and practical experience from the U.S. and other countries are the basis of the seven critical topics. The International Civil Aviation Organization (ICAO), the U.S. Occupational Safety and Health Administration (OSHA), Airlines for America (A4A), Transport Canada, United

Kingdom Civil Aviation Authority (UK CAA), the European Aviation Safety Agency (EASA), the International Air Transport Association (IATA), and information from other entities contributed to this manual. The seven contributors to this manual have worked in aviation maintenance, medicine, and engineering for an average of 35 years. The contributors characterized the seven topics and related steps discussed in this manual as "information they wish they had known years ago."

These straightforward suggestions provide the key components for setting up and/or overseeing successful human factors programs that will benefit your company, business partners, external customers, employees, and the entire industry. The suggestions will also help to ensure compliance with human factors regulations, as appropriate. Keep in mind the following points when using this manual:

- These are seven topics, from many, that a maintenance human factors program may consider.
- Topics are not necessarily in order of importance.
- Apply any or all of the topics; however, they should be coordinated.
- Base your human factors activity on the identified requirements and resources of your organization. One size does not fit all.
- The role of company leadership, with labor representation, is critical in establishing and sustaining a human factors program.
- Supplement this operator's manual with additional references as necessary.
- Human factors programs are a critical part of your safety management system and corporate safety culture.

Why Use the Operator's Manual?

You may ask, "What is in it for me?" Below are some of the many reasons for using the information in this manual.

- ICAO Safety Management System (SMS) standards and the evolving regulations are requiring programs to collect the proactive and predictive data offered by voluntary reporting systems (see Chapter 1).
- A 2007 European Aviation Safety Agency (EASA) Safety Analysis and Research study analyzed all worldwide commercial aircraft accidents from 1990 to 2006 and found that in 8% of the accidents, the primary cause was maintenance (see Chapter 1).
- A summary of multiple airlines and maintenance, repair, and overhaul (MRO) organizations shows that challenges from technical publications and company

procedures are in the top four most reported events from FAA's Aviation Safety Action Program (ASAP) (see Chapter 2).

- The #1 factor for which FAA initiates Letters of Investigation (LOI) and takes administrative actions on AMTs is failure to follow written procedures as defined in Advisory Circular (AC) 43.13-1 (A&B) (see Chapter 2).
- The National Aeronautics and Space Administration (NASA) reports that, from 2010 to 2013, approximately 83% of maintenance Aviation Safety Reports (ASRs) was related to technical publications and other written company procedures (see Chapter 2).
- Training is a critical part of every aviation industry position. Halldale Publishing estimates that the annual expenditures on all training equipment, services, and personnel exceeds $500 billion USD (see Chapter 3).
- Training is inevitability the top intervention for identified organization risk reduction (see Chapter 3).
- Human Factors training is instrumental in fostering a positive safety culture and serves to introduce the workforce to concepts related to risk assessment, voluntary reporting, event investigation, and peer-to-peer support (see Chapter 3).
- One study found that fatigue costs employers more than $136 billion USD per year in health-related lost productivity and that the majority (84%) of the costs related to reduced work performance (see Chapter 4).
- According to operational data collected in a maintenance organization, individuals working 16-hr days or longer were four times more likely to be involved in a personnel injury incident/accident than an individual working an 8 hr day (see Chapter 4).
- Changes in the workforce are perceptible with 19% of the current workforce over age 55 years and 27% in the obese weight category (see Chapter 5).
- Telephone interviews using the U.S. Census Occupational Code systems show that the occupation "aircraft engine mechanics" ranked 48th in mortality among 206 occupations included in the census (see Chapter 5).
- The National Business Aircraft Association Safety Committee has made pilot adjustment to advanced avionics systems one of its top focus areas for 2014.[1] Proper installation and attention to human factors issues is an important contribution to the safety goal (see Chapter 6).
- Inspection Authorization certificate holders and FAA Aviation Safety Inspectors (ASIs) have expressed the need for human factors guidance for avionics and other appliance installations and approvals during discussions in Inspection Authorization renewal workshops (experience from authors Johnson and Brys) (see Chapter 6).

- When not driven by regulation, human factors programs and other safety interventions demonstrate an impact on cost and other safety-related performance measures (see Chapter 7).
- Since 2010, industry has applied the FAA Return on Investment (ROI) procedures and software to demonstrate positive return on safety interventions that have reduced ground damage, affected worker communication, streamlined the application of technical manuals for cabin crew, reduced rework and equipment damage by changing procedures, and more (see Chapter 7).
- FAA/Industry surveys in 2010 and 2014, identified "Establishing the Value of Human Factors" among the top 5 challenges related to maintenance human factors.[2,3]

Key References and Links

1. National Business Aviation Association. http://www.nbaa.com
2. Johnson, W.B. (2010). Maintenance Human Factors Leaders Workshop Proceedings. Retrieved from: http://www.faa.gov/about/initiatives/maintenance_hf/library/documents/media/roi/mx_hf_wrkshop_proceedings_final_report_with_cover_reduced.pdf
3. Avers, K.E., Johnson, W.B., Banks, J.O., & Wenzel, B. (2014). The Transition from Event Reports to Measurable Organizational Impact: Workshop Proceedings Report. Retrieved from: http://ntl.bts.gov/lib/51000/51600/51649/201405.pdf

HAZARD IDENTIFICATION

Chapter 1

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Airline and MRO Safety Management Systems (SMS) have advanced rapidly in the past decade. Conceived by the International Civil Aviation Organization (ICAO) and put into practice through regulation by the national aviation authorities, SMS will soon be a standard requirement for airlines around the world. Airlines will be required to implement SMS in various organizations within the airline, including the Maintenance and Engineering function, while national aviation authorities are passing regulations requiring maintenance organizations to implement an SMS as well.

One of the major components of an SMS is Risk Management. Risk Management requires that safety of flight hazards be identified, that the hazards be assessed for risk, and that unacceptable risk be mitigated to acceptable levels.

A hazard is a potential source of harm; for example, a condition, object, or activity with the potential of causing injuries to personnel, damage to equipment or structures, loss of materials, or reduction of the ability to perform a prescribed function. Because an SMS is regulated by national aviation authorities, these hazards relate specifically to safety of flight. However, many airline maintenance and engineering organizations also include hazards related to personal injury, equipment damage, and environmental damage in their SMS. Risk is defined as the hazard consequence severity times the probability of attaining that severe a hazard consequence.

An SMS recommends three approaches in identifying safety hazards (see Figure 1):

1. Reactive approach—investigation of accidents, incidents, and events.
2. Proactive approach—active identification of safety hazards through the analysis of the organization's activities, using tools such as mandatory and voluntary reporting systems, safety audits, and safety surveys.
3. Predictive approach—capturing system performance as it happens in real-time during normal operations such as observations of AMT performance during a heavy check.

Figure 1. Three Complementary Approaches for Hazard Identification

In the previous version of the Operator's Manual (2006), this chapter was entitled "Event Investigation." However, because of the movement to implement SMS in the industry, and because event investigation is only one of three important hazard identification approaches, this updated chapter in the Operator's Manual update will discuss all three hazard identification approaches.

1.1 Why Hazard Identification Is Important

A. Hazard identification is part of a major component of an SMS.

B. Incorrectly performed maintenance, due to workplace hazards, has been the second leading primary cause (after pilot error) of commercial aircraft hull-loss accidents over the past several decades.

   a. A European Aviation Safety Agency (EASA) Safety Analysis and Research study, which analyzed all worldwide commercial aircraft accidents from 1990 to 2006,[10] found that in 8% of the accidents, maintenance was the primary cause.

   b. Maintenance was the primary causal factor of 3% of global fatal accidents between 2002 and 2011.[11]

   c. The International Air Transportation Association Safety Reports (IATA) from 2003 – 2008 found that incorrectly performed maintenance was causal (either as a primary cause or an initial link in the accident chain) in 20% to 40% of the worldwide aircraft accidents for those years.[12]

   d. Maintenance events counted as an average of 10% of threats that led to 432 aircraft accidents between 2009 and 2013. Maintenance Operations, including Standard Operating Procedures and Training Systems, were found to be a latent condition for 8% of the 338 non-fatal accidents worldwide between 2009 and 2013.[12]

Threat: *Any condition that increases the complexity of the operations, and, which, if not managed properly, can decrease safety margins and lead to errors.*

Latent condition: *Conditions present in the system before the accident and triggered by various possible factors.*

C. The Flight Safety Foundation estimates that 27,000 ramp accidents and incidents, one per 1,000 departures occur worldwide each year. The injury rate is 9 per 1,000 departures. Ramp accidents cost major airlines worldwide at least $10 billion USD a year.
D. Hazard identification programs help identify and communicate hazards or factors contributing to errors and violations to create corrective actions and prevent future events.
E. Hazard identification programs, such as event investigation, are a primary requirement for identifying and communicating human performance issues within an organization.

1.2 How to implement a Hazard Identification process

The three different hazard identification processes may be owned and maintained by different functions within the Maintenance and Engineering organization. Reactive processes are often owned by Quality Assurance, although they can also be owned by a safety department or production. Proactive processes are often owned by Quality Assurance and Safety. Predictive processes are often owned by production. However, all of them have some basic requirements for implementation.

A. Select a manager/department to be responsible for the process.
B. From the very beginning, ensure that the program is a cooperative endeavor of labor, management, and, if appropriate, the regulator. Obtain the buy-in and participation of frontline employees because they are a valuable asset in discovering hazards (see Figure 2).
C. Write the policies and procedures needed to implement the process.
D. Develop and implement a reasonable, consistently applied, company disciplinary policy and/or implement a Just Culture.

Figure 2. The Iceberg of Ignorance

1.2.1 Reactive Hazard Identification Processes

A. Select an investigation process, like the Boeing Maintenance Error Decision Aid (MEDA), that systematically determines the hazards or contributing factors to events, and, based on these findings, allows the organization to develop and monitor a comprehensive fix.
B. Select and train all investigators—management as well as labor—in a consistent manner to minimize interpretation differences later. Invite/encourage regulatory inspectors to attend such training sessions.
C. Identify screening criteria to determine which events will be investigated.
D. Establish a team to review the investigation findings and to select areas for improvement.
E. Inform all personnel on the status of improvements in progress. Use newsletters, company/labor websites, crew meetings, and posters to demonstrate and remind everyone that the process is working and somebody is actually tracking the progress.
F. Create a database for documenting investigation information and measures of change.