



**U.S. Department
of Transportation**
Federal Aviation
Administration

Advisory Circular

Subject: Maintenance Human Factors
Training

Date: DRAFT

AC No: 120-72A

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Change:

- 1 PURPOSE.** This advisory circular (AC) presents sources of information for certificate holders to develop, implement, reinforce, and assess aircraft maintenance human factors (MxHF) training programs. This document provides references to supplementary MxHF training materials that will help ensure continuing efficiency, effectiveness, and safety in maintenance operations. This AC, as any AC, is not mandatory and does not constitute a regulation; rather it provides many sources of information to develop, implement, reinforce, and assess MxHF training. This AC contains a detailed listing of information sources and resources that will help the reader to prepare for and deliver an up-to-date MxHF training program to ensure continued efficiency, effectiveness, and safety in maintenance operations.
- 2 CANCELLATION.** This AC cancels AC 120-72, Maintenance Resource Management Training, dated September 28, 2000.
- 3 WHERE YOU CAN FIND THIS AC.** Certificate holders and the public may find this AC at http://www.faa.gov/regulations_policies/advisory_circulars.
- 4 AUDIENCE.** This AC applies to the following regulated entities:
 - Foreign air carriers or foreign persons operating a U.S.-registered aircraft in accordance with Title 14 of the Code of Federal Regulations (14 CFR) part 129, § 129.14.
 - Air carriers or air operators conducting operations in accordance with 14 CFR part 121 or 135.
 - Operators conducting operations in accordance with 14 CFR parts 91, 91 subpart K (part 91K), 125, 133, or 137.
 - Airmen certification course operators who provide instruction and evaluation in accordance with 14 CFR part 65 or 147.
 - Persons performing airmen certification in accordance with part 65 or 147.
 - Individuals performing maintenance or preventive maintenance in accordance with 14 CFR part 43.
 - Repair stations operating in accordance with 14 CFR part 145.

- Aviation Maintenance Technician School (AMTS) who provide instruction and evaluation in accordance with part 147.
- Organization Designation Authorization (ODA) holders, under 14 CFR part 183 subpart D.

5 DEFINITIONS. For the purposes of this AC, the terms listed below have the following meanings:

1. Active Failure. A type of human error whose effects are felt immediately in a system.
2. Certificate Holder. Air carriers, operators, and air agencies.
3. Compliance Philosophy. A Federal Aviation Administration (FAA) recognition, established in 2015, that most operators comply with regulations and also use Safety Management Systems (SMS) to identify hazards and mitigate risk. The philosophy focuses on avoiding strict enforcement action for inadvertent violations/mistakes.
4. Crew Resource Management (CRM). Team-based human factors (HF) training for flightcrews.
5. Dirty Dozen. The twelve most common maintenance-related causes of errors. These twelve causes are:
 - Lack of Communication.
 - Complacency.
 - Lack of Knowledge.
 - Distraction.
 - Lack of Teamwork.
 - Fatigue.
 - Lack of Resources.
 - Pressure.
 - Lack of Assertiveness.
 - Stress.
 - Lack of Awareness.
 - Norms.
6. Ergonomics. The applied science having the objective of adapting work, working conditions, and equipment to enhance performance of the worker.
7. Human Factors (HF). HF is a multidisciplinary field that generates and compiles information about human capabilities and limitations, and applies it to design, development and evaluation of equipment, systems, facilities,

- procedures, jobs, environments, staffing, organizations, and personnel management for safe, efficient and effective human performance.
8. Instructional Systems Design (ISD). A generic term for the methodology of creating and implementing a training program.
 9. Leadership. The ability to direct and coordinate the activities of group members and stimulate them to work together as a team.
 10. Maintenance Resource Management. A general process for maintaining an effective level of communication and safety in maintenance operations. This term was more widely used in the 1990s than currently. The term Maintenance Human Factors is more descriptive and widely used.
 11. People, Environment, Actions, Resources (PEAR). A summary of the concept suggesting that the following words help describe any HF situation to include: People; Environment; Actions; and Resources.
 12. Safety Culture. A pervasive, organization-wide attitude placing safety as the primary priority driving the way employees perform their work.
 13. SMS. A formal, top-down business approach to managing safety risk, which includes a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies, and procedures.

6 ACRONYMS.

1. CRM. Crew Resource.
2. HF. Human Factors.
3. ICAO. International Civil Aviation Organization.
4. ISD. Instructional Systems Design.
5. MxHF. Maintenance Human Factors.
6. MROs. Maintenance and Repair Organizations.
7. PEAR. People, Environment, Actions, Resources.
8. SMS. Safety Management System.

7 BACKGROUND.

- 7.1 CRM Transition.** CRM on the flight deck started the attention to MxHF in the late 1980s. It remains important for continuing safety. The aviation community has expanded its approach to continuing safety by identifying, analyzing, and managing risk. The original AC 120-72 (September, 2000) covers the transition from CRM to MxHF.
- 7.2 MxHF Implementation.** Since 2000, there has been an extensive acceptance of the importance of HF training and programs for maintenance environments. Many MROs and U.S. carriers, with European Aviation Safety Agency (EASA) part 145 certificate, have implemented required HF programs since 2005. FAA Airworthiness inspectors have

been taking the three day HF course since 2006. Required or not, U.S. maintenance organizations and airlines have implemented MxHF programs for commercial reasons, like worker safety and reduced maintenance rework. Part 145, § 145.163 requires MxHF training and offers topical areas that should be covered. Those topics align with most international regulations and guidelines.

- 7.2.1** Part 147 Rule Change. In 2016, the FAA issued a rule change to part 147. This rule required that the curriculum integrate HF. A detailed list of HF topics is listed in the rule change. The content aligns with the same training rule published by EASA.
- 8** **TRAINING SUMMARY.** Delivering new and modern HF training does not have to be complicated. Appendix A provides the links to all necessary materials. The two most significant available training programs are available from the FAA and from the Civil Aviation Safety Authority (CASA) of Australia (See Appendix A for Web sites). Whatever material you decide to use, it should match your organizational needs that your corporate SMS dictates.
- 9** **AC FEEDBACK FORM.** For your convenience, the AC Feedback Form is the last page of this AC. Note any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this AC on the Feedback Form.

John S. Duncan
Director, Flight Standards Service

APPENDIX A. RELATED MATERIAL.

A.1 References. The references in this Appendix contain links and information to a variety of hardcopy and multimedia training for HF to empower those who develop and deliver MxHF training. The most important links are to the FAA and CASA HF training Web sites. The following bibliographic information is critical to the value of this AC. It is the most important part of the AC because it takes you to the best information sources. It brings together a detailed listing of information sources that help the reader to prepare for and deliver up-to-date MxHF training. This document does not attempt to include the content of these resources due to the abundance of material. Many of the references contain annotations to help guide the reader.

A.1.1 HF. The documents below focus on a variety of general, as well as maintenance-specific, HF materials. Many are available at no cost from the FAA and other National Aviation Authorities (NAA).

1. Aircraft Technical Books Company (2016). *Module 9 Human Factors Training*. Tabernash, CO. Available at: www.actechbooks.com.
2. Civil Aviation Authority (2009). *Aviation Maintenance Human Factors, EASA Part-145 (CAP 716)*. West Sussex, UK. Available at: <http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=275>
3. Civil Aviation Safety Authority of Australia (2013). *Safety Behaviours: Human Factors for Engineers. A Multimedia Training System*. Available by request from: safetyproducts@casa.gov.au.

Note: The training materials, including videos, available at this site are an absolute must for HF trainers.

4. Dekker, S. (2006). *The Field Guide to Understanding Human Error*. Burlington, VT: Ashgate.
5. Federal Aviation Administration (2006, 2nd edition). *The Human Factors Guide for Aviation Maintenance and Inspection*: www.humanfactorsinfo.com.
6. Federal Aviation Administration (2000). *AC Maintenance Resource Management Training*. (Advisory Circular 120-72.) Washington, DC: Federal Aviation Administration.

Note: This document is the original MxHF training AC document. When written, the emphasis was from the perspective of organizational psychology. Portions of that AC remain relevant for such HF topics as teamwork, communication, and leadership. It also has a section dedicated to training system development, but many of the training system development references are superseded by Appendix A of this document.

7. Federal Aviation Administration (2005). *Crew Resource Management Training*. (Advisory Circular 120-51.) Washington, DC: Federal Aviation Administration.
8. Federal Aviation Administration (2005). *Repair Station Training Program*. (Advisory Circular 145-10.) Washington, DC: Federal Aviation Administration.

Note: This AC addresses all aspects of maintenance training-specific design, development, delivery, and evaluation. It makes recommendations for HF training content so that it also meets EASA Foreign Part 145 requirements.

9. Federal Aviation Administration (2007). FAA Order 8900.1 Volume 3, Chapter 55, Section 1, Review and Approve a Part 145 Repair Station’s Training Program. Available via Flight Standards Information Management System (FSIMS). (8900.1 CHG 220.) Washington, DC: Federal Aviation Administration.

Note: This guide shows what the FAA inspectors look for in your training.

10. Federal Aviation Administration (2010). *Basics of Aviation Fatigue*. (Advisory Circular 120-100.) Washington, DC: Federal Aviation Administration.

Note: The FAA prepared this material for flight operations, but it is relevant to maintenance.

11. Federal Aviation Administration (2010). *Fatigue Risk Management Systems for Aviation Safety*. (Advisory Circular 120-103.) Washington, DC: Federal Aviation Administration.

Note: The FAA prepared this material for flight operations, but it is relevant to maintenance.

12. Federal Aviation Administration (2012). *Fitness for Duty*. (Advisory Circular 117-3.) Washington, DC: Federal Aviation Administration.

Note: The FAA prepared this material for flight operations, but it is relevant to maintenance.

13. Federal Aviation Administration (2013). *Fatigue Education and Awareness Training Program*. (Advisory Circular 117-2.) Washington, DC: Federal Aviation Administration.

14. Federal Aviation Administration (2014). Part 145, § 145.163, Training Requirements. Washington, DC: Federal Aviation Administration.

15. Hobbs, A., Avers, K. B., Hiles, J. J. (2011). *Fatigue Risk Management in Aviation Maintenance: Current Best Practices and Potential Future*

Countermeasures. (Technical Report DOT/FAA/AM-11/10.) Washington, DC: Federal Aviation Administration Office of Aerospace Medicine.

Note: This document discusses many aspects of maintenance related fatigue and offers suggested interventions.

16. infoWerk-Media (2016). *Training for Human Factors and for Fatigue Risk Management*. Zirl, Austria. Available at: www.infowerk.at.

17. Johnson, W. B. (2007). *The Maintenance Human Factors Presentation System*: www.humanfactorsinfo.com.

Note: Multimedia presentation with 135 PowerPoint slides with notes and 11 video programs written and co-produced by William B. Johnson. It is an absolute “must have” for those developing or modifying MxHF training.

18. Johnson, W. B. (2010). *Grounded*. Available at www.humanfactorsinfo.com.

Note: A maintenance fatigue story written for video. Produced on September 14, 2010, this award-winning video can be used for initial HF training, continuation training, or merely for fatigue awareness training. Also available on YouTube.

19. Johnson, W. B. (2015). “Human factors training: how FAA trains airworthiness inspectors.” *Aircraft Maintenance Technology*. August 2015, pages 30–31.

20. Johnson, W. B. (2015). “Two countries apply trusted human factors model to manage safety.” *Aviation MX Human Factors Newsletter*. Volume 3, Issue 1, March 2015. (Refer to www.humanfactorsinfo.com.)

21. Johnson, W. B. (2013). “Maintenance human factors training: time for curricula renewal.” *Aviation MX Human Factors Newsletter*. Volume 1, Issue 4, December 2013. (Refer to www.humanfactorsinfo.com.)

22. Johnson, W. B. (2013). “Need HF training? Look down under.” *Aircraft Maintenance Technology*. September 2013, pages 36–40.

23. Johnson, W. B. and Avers, K. A. (Eds.) (2014). *The Operator’s Manual for Human Factors in Aviation Maintenance*. Washington, DC: Federal Aviation Administration Office of Aerospace Medicine. (Refer to www.humanfactorsinfo.com.)

Note: Chapter 3 is dedicated to HF training.

24. Johnson, W. B. and Bryant, M. (2015). “A human factors program health checklist.” *Aviation MX Human Factors Newsletter*. Volume 3, Issue 3, September 2015, pages 1–5. (Refer to www.humanfactorsinfo.com.)

Note: While this is a HF program checklist, it can also be a training aid.

25. Lufthansa Technical Training (2016). *Computer-based Training for Human Factors*. Frankfurt, Germany. Available at: www.ltt-onlinetraining.de/Data/ltt/presentation/samples/hf/hdocs/. (Refer to www.ltt.aero.)
26. Reason, J. T. and Hobbs, A. (2003). *Managing Maintenance Error: A Practical Guide*. Hampshire, UK: Ashgate.
27. Reason, J. T. (1997). *Managing the Risks of Organizational Accidents*. New York, NY: Ashgate.
28. Salvendy, G. (Ed.) (1997). *Handbook of Human Factors and Ergonomics*. New York, NY: John Wiley & Sons.

A.1.2 HF and Industrial Safety Web Sites.

1. Aviation Human Factors Industry News. <http://www.system-safety.com/Aviation%20HF%20News/AVIATION%20HUMAN%20FACTORS%20INDUSTRY%20NEWS.htm>.

Note: This monthly newsletter provides interesting and valuable new information to refresh your HF classes.

2. Aviation MX Human Factors Newsletters. https://www.faa.gov/about/initiatives/maintenance_hf/fatigue/publications/.

Note: This quarterly newsletter provides interesting and valuable new information to refresh your HF classes.

3. CAA UK List of Human Factors Publications. <http://www.caa.co.uk/Our-Work/Publications/Publications/>.
4. FAA Lessons Learned From Transport Airplane Accidents—Accident Common Themes—Human Error. <http://lessonslearned.faa.gov/>.

Note: An award-winning Web site that helps one learn about HF from event experiences.

5. Health and Safety Executive (United Kingdom): Human Factors and Ergonomics Web site. <http://www.hse.gov.uk/humanfactors/>.
6. Human Factors and Ergonomics Society—Publications. <http://www.hfes.org/publications/>.

Note: This site provides general HF information, not necessarily related to maintenance.

7. Human Factors in Aviation Maintenance. http://www.faa.gov/about/initiatives/maintenance_hf/.

Note: This is the largest MxHF resource in the world. We strongly suggest bookmarking it.

8. Ford, J.K. (2014). *Improving Training Effectiveness in Work Organizations*. New York, NY: Psychology Press.
9. Skybrary Human Factors Training.
http://www.skybrary.aero/index.php/Main_Page.

A.1.3 Training Design Resources. These documents are extremely important information sources for training system design. If you have to build training you must look at these sources. Remember that there are a lot of HF training materials available where the design work is already completed. The FAA and CASA materials are but two examples.

1. American Society for Training and Development (2008). *ASTD Handbook for Workplace Learning Professionals*.
2. American Society for Training and Development Editors (2007). *Instructional Systems Development: An Infoline Collection*.
3. ATA Spec 104 (Rev 2 in press 2016).
<https://publications.airlines.org/CommerceProductDetail.aspx?Product=11>.
4. Barbazette, J. (2007). *Managing the Training Function for Bottom Line Results: Tools, Models and Best Practices*. John Wiley & Sons. (Essential Tools Resource.)
5. Biech, E. (2009). *10 Steps to Successful Training*. ASTD Press.
6. FAA HF Research and Engineering group web portal–HF Training.
<http://www.hf.faa.gov/training.aspx>.
7. Hodell, C. (2004). *Basics of Instructional Systems Development*. ASTD Press.
8. Johnson, W. B. (2008). “Designing Training Programs for Human Factors”—a chapter in *The Maintenance Human Factors Guide, 2nd Edition*. (Refer to www.humanfactorsinfo.com.)
9. Kirkpatrick, D. L. and Kirkpatrick, J. D. (2007). *Implementing the Four Levels: A Practical Guide for Effective Evaluation of Training Programs*. Berrett-Koehler.
10. Morrison, G. R., Ross, S. M., and Kemp, J. E. (2006). *Designing Effective Instruction*. John Wiley & Sons.
11. Phillips, J.J. and Pulliam-Phillips, P. (2005). *ROI at Work*. ASTD Press.
12. Rothwell, W. J. and Kazanas, H. C. (2008). *Mastering the Instructional Design Process: A Systematic Approach*. John Wiley & Sons.
13. Walter, D. (2002). *Training on the Job*. ASTD Press.

A.1.4 ICAO Documents. The following ICAO documents are available from:

ICAO
Document Sales Unit
1000 Sherbrooke Street West, Suite 400
Montreal, Quebec
Canada H3A 2R2
Phone: (514) 285-8022
Fax: (514) 285-6769
Email: sales unit@icao.org

1. International Air Transport Association, International Civil Aviation Organization, International Federation of Air Line Pilots' Associations (2011). *Fatigue Risk Management Systems: Implementation Guide for Operators*.
2. International Civil Aviation Organization (1989). *Flight Crew Training: Cockpit Resource Management (CRM) and Line-Oriented Flight Training (LOFT)*. (Circular 217-AN/132.) Montreal, Canada.
3. International Civil Aviation Organization (1993). *Human Factors, Management and Organization*. (Circular 247-AN/148.) Montreal, Canada.
4. International Civil Aviation Organization (1995). *Annex 6: To the Convention on International Civil Aviation, Part I: International Commercial Air Transport-Aeroplanes*. Montreal, Canada.
5. International Civil Aviation Organization (1995). Human Factors Digest Number 12. *Human Factors in Aircraft Maintenance and Inspection*. Montreal, Canada.

Note: This document provides a very good overview of the problems in aviation maintenance. It uses a few high profile accidents to illustrate its points and discusses the importance of looking past the obvious micro issues to organizational culture factors, which contribute to latent failures and overall systems problems.

6. International Civil Aviation Organization (2013). *Safety Management Manual (SMM), 3rd edition*. (Doc 9859-AN/474.) Montreal, Canada.
7. International Civil Aviation Organization (2009). *Safety Management Manual (SMM), 2nd edition*. (Doc 9859-AN/474.) Montreal, Canada.
8. International Civil Aviation Organization (2011). *Fatigue Risk Management Systems—Manual for Regulators*. (Doc 9966.) Montreal, Canada.

Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by contacting the Flight Standards Directives Management Officer at 9-AWA-AFS-140-Directives@faa.gov.

Subject: AC 120-72A, Maintenance Human Factors Training

Date: _____

Please check all appropriate line items:

An error (procedural or typographical) has been noted in paragraph _____ on page _____.

Recommend paragraph _____ on page _____ be changed as follows:

In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

Other comments:

I would like to discuss the above. Please contact me.

Submitted by: _____

Date: _____