

Maintenance Human Factors: Concepts & Challenges

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TWU/AA System Safety Meeting
Dallas, November 13 - 14, 2006



Federal Aviation
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Agenda

Human Factors Concepts – Key Examples

Considerations & Topics for FAA HF Attention

Selected 2005-2006 Accomplishments

Future Challenges and Plans



Human Factors Spectacles



TWU/American Airlines System Safety Meeting

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Human Factors Goal – Simply Stated

Ensure continuing safety and efficiency by paying attention to issues surrounding human performance.



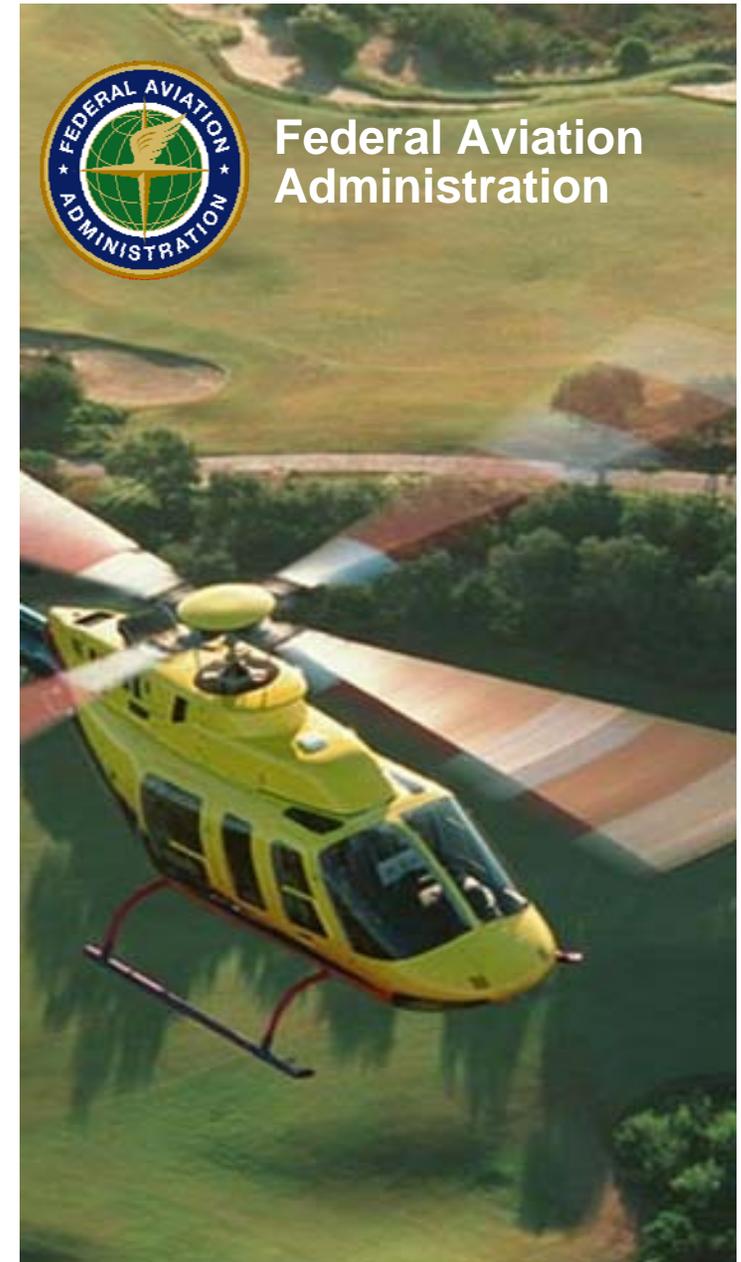
Maybe we all need some “thought control?”

Most of our errors are in thinking rather than lack of knowledge.

Think about your actions that may lead to error.

Save time and money?

Apply principles to life.



Maintenance Errors and the Consequences

Jan 2000	Alaska Airlines	Boeing MD-80	Jackscrew for Elevator Control
Mar 2001	Lufthansa Airbus	A320	Mis-wired side stick
Apr 2001	Emery Worldwide	DC-8	Reversed hyd. check-valve
Aug 2001	Air Transat	A310	Fuel exhaustion over Atlantic
May 2002	China Airlines	B747-200	In flight break-up at 35K Ft.
Jan 2003	Air Midwest	Beech1900D	Trim Rigging
Aug 2003	Colgan Air	Beech 1900D	Trim Rigging
July 2006	Spectrum Aircraft	Spectrum 33	Mis-Rigging



Boeing's top 7 Errors 276 In-flight shutdowns (1994)

- Incomplete installation (33%)
- Damage on installation (14.5%)
- Improper installation (11%)
- Equipment not installed or missing (11%)
- FOD (6.5%)
- Improper troubleshooting, inspection, test (6%)
- Equipment not activated or deactivated (4%)



The 12 Common Human Errors

The Dirty Dozen

Lack of Communication

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Lack of Knowledge

Lack of Awareness

Lack of Resources

Distraction

Assertiveness

Fatigue

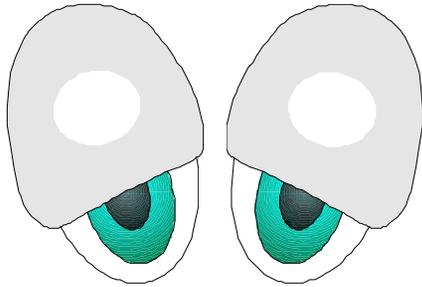
Stress

HUMAN ERROR

[Link](#)

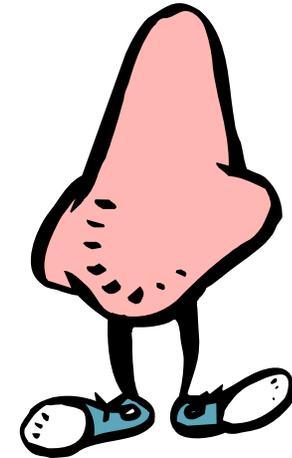


Sensing and Perception



Human Senses

Human Factors
Human Factors
Human Factors



How to Remember the 5 Senses



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What does this mean?

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7 days per week X 24 hours per day X 365 days per year

ACTORS AFFECTING PERFORMANCE AND WORK ACTIVITY

Link

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The Fatigue Issue is not New!

“O sleep, O gentle sleep, Nature’s soft nurse”

William Shakespeare



1564-1616



Types of Fatigue

Acute Fatigue

Intense

Short Duration

Cured with a good night's sleep

Fatigue

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Acute fatigue

Chronic fatigue

Chronic Fatigue (harder to fix)

Frequent recurrence

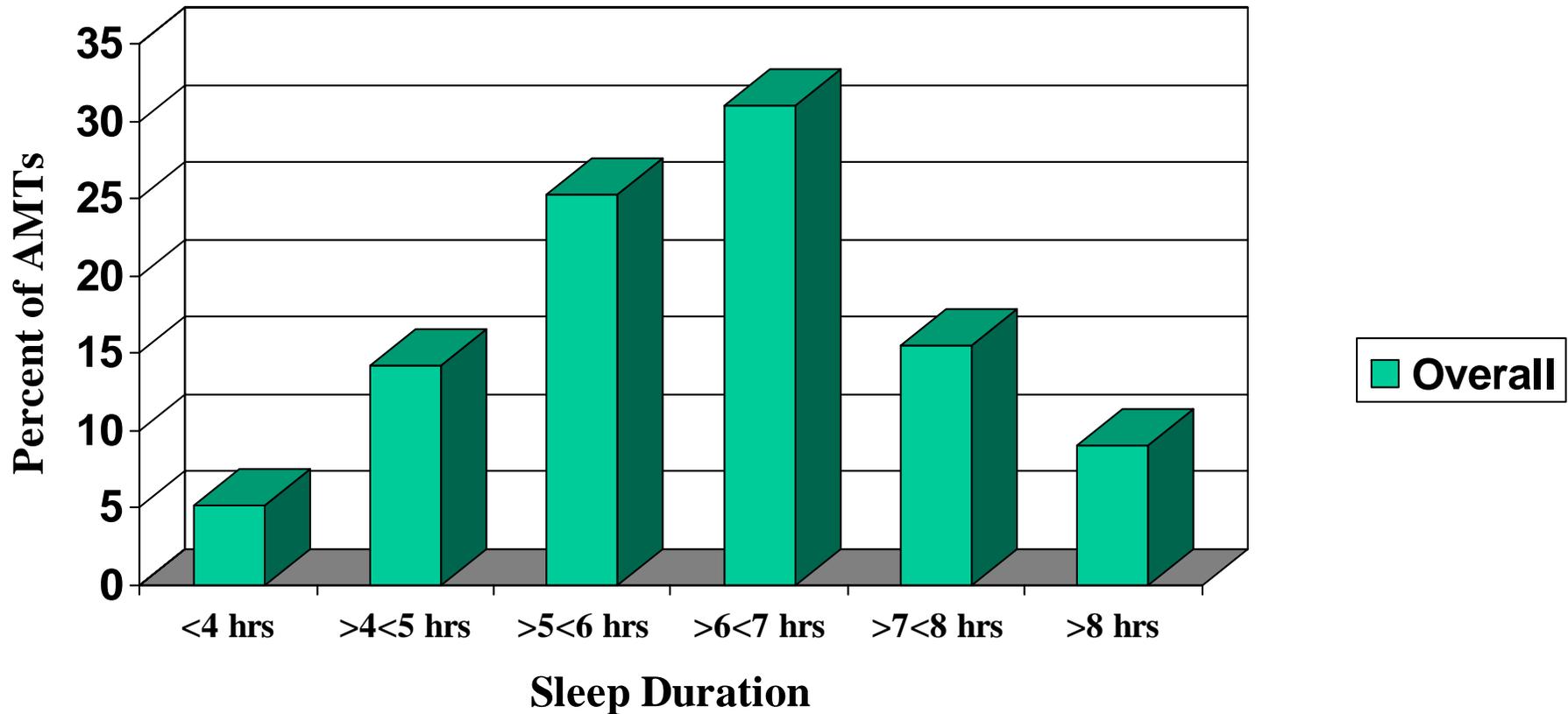
Long duration

Slow recovery

Often a physical sickness or mental stress causing chronic fatigue.



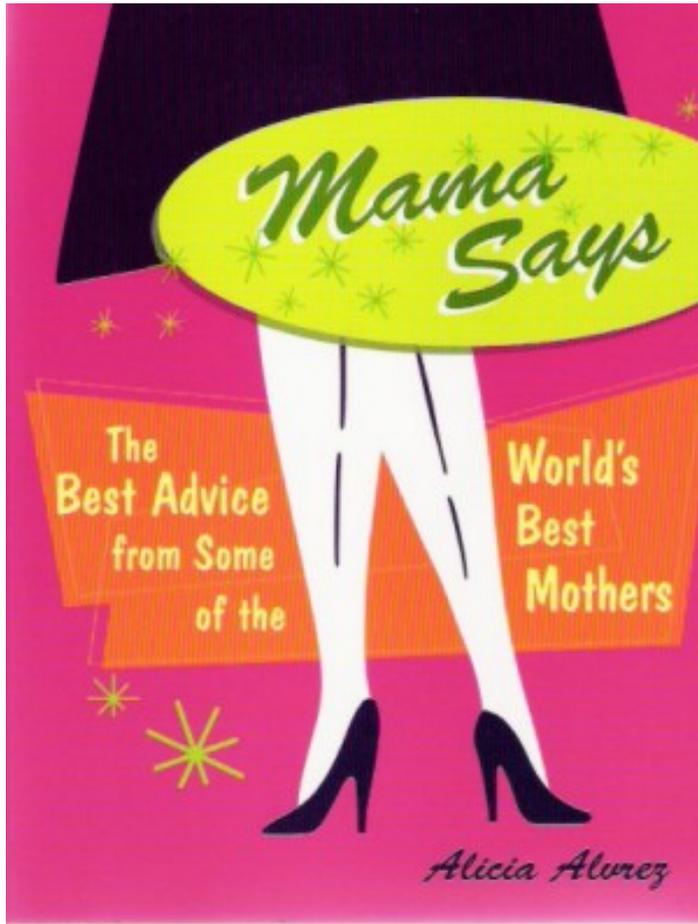
Percent of AMTs from All Shifts by Sleep Duration



Johnson, et al, 2001



Regarding sleep: Do what your mama told you.



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How to define topics for Mx HF Attention

- Apply resources to high payoff opportunities
- Ensure that R&D can be applied, but do not ignore good science
- Attack present challenges with an eye to the future
- Communicate in plain language



How to Accomplish the Human Factors Goals

Attention to:

- people,
- the environment in which they work,
- the actions they perform,
- and the resources necessary to perform the work.



PEAR Details: People

- **Physical Factors**
- **Physical size**
- **Sex**
- **Age**
- **Physical characteristics**
- **Strength**
- **Sensory limitations**
- **Physiological Factors**
- **Nutrition**
- **Health**
- **Lifestyle**
- **Fitness for Duty**
 - **Alertness**
 - **Chemical Dependence**
- **Workload**
- **Experience**
- **Knowledge**
- **Training/Certification**
- **Attitude**
- **Mental or emotional state**
- **Interpersonal conflicts**
- **Personal loss**



PEAR Details: Environment

Physical Environment

- **Weather**
- **Location inside/outside**
- **Workspace**
- **Shift**
- **Lighting**
- **Noise**
- **Safety**

Organizational Environment

- **Personnel**
- **Supervision**
- **Union management relations**
- **Pressures**
- **Crew structure**
- **Size of company**
- **Profitability**
- **Morale**
- **Culture**



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- *The Operator's Manual for Human Factors in Aviation Maintenance* (www.hf.faa.gov/opsmanual)

- Plain Language Award
- Published in 3 Languages
- Widely – adopted by industry
- Many website hits with document downloads 3000+



- Support of FAR 145 Rule with Guidance Material
- Study of language-related error in maintenance





Operator's Manual
Human Factors
in Aviation Maintenance
Last update: 10/5/2005



Download Document

Search

Introduction

1.0 Event Investigation

2.0 Documentation

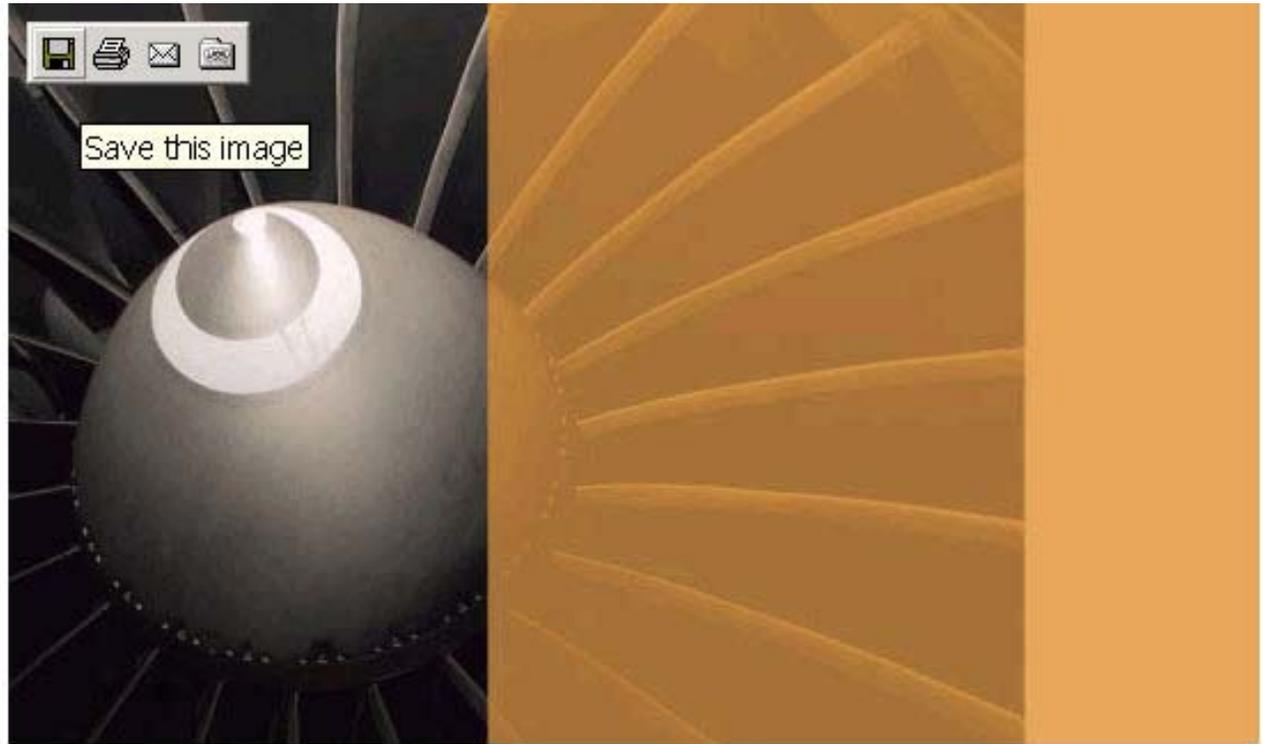
3.0 Human Factors

4.0 Shift/Task Turnover

5.0 Fatigue Management

6.0 Sustaining & Overhaul

Acknowledgements



Introduction

This manual is in response to the industry's requests for a simple and manageable list of actions to implement a Maintenance Human Factors (MHF) program. A panel of experts selected the following six topics for such a program to be successful:





"Jackscrew assembly failure caused by excessive wear resulting from insufficient lubrication... contributing factors included extended lubrication and end-play check intervals, lack of available parts, organizational norms, regulatory oversight issues, etc."

NTSB AAR-02/01 FINAL REPORT

EVENT INVESTIGATION

Chapter 1

<< < Page 1 of 5 > >>



"Departures from approved procedures included failures to solicit and give proper shift-change turnover reports, failures to use maintenance work cards as approved, failures to complete required maintenance/inspection shift turnover forms, and a breach in the integrity of the quality control."

NTSB AAR-92/04 EAGLE LAKE

Shift / Task Turnover

Chapter 4

<< < Page 1 of 5 > >>



"Mechanics would benefit from using Airliner Maintenance Manuals with more specific instructions for critical flight system procedures."

NTSB/AAR-04/01

DOCUMENTATION

Chapter 2

<< < Page 1 of 5 > >>



"A combination of 16 hours of straight work compounded by influenza contributed to fatigue and falling asleep at the wheel..."

AIRPORT INTERNAL REPORT

FATIGUE MANAGEMENT

Chapter 5

<< < Page 1 of 5 > >>



"The Safety issues raised in this report include: The Human Factors aspects of air carrier maintenance and inspection for the continuing airworthiness of transport category airplanes, to include repair procedures and the training, certification and qualification of mechanics and inspectors."

NTSB AAR-89/03 FINAL REPORT



"...various initiatives come and go sometimes based on corporate whims... a sustainable maintenance human factors program must have shared support from senior management and all levels of company personnel... the program must show value in continuing safety, worker job satisfaction, and cost control..."

W.B. JOHNSON, FAA

SUSTAINING & JUSTIFYING AN HF PROGRAM

Chapter 6

<< < Page 1 of 5 > >>

HUMAN FACTORS TRAINING

Chapter 3

<< < Page 1 of 5 > >>



Key References for Each Chapter



6.0 Sustaining & Justifying an HF Program

6.6 Key References

- A. Sustaining & Justifying an HF Program presentation ([Download Document](#)).
- B. Stelly, J. and Poehlman, K. 2000. Investing in Human Factors Training: Assessing the Bottom Line. Presented at the 14 th Annual Human Factors in Aviation Symposium. Vancouver, Canada. ([Download Document](#)).
- C. Patankar, M.S., and Taylor, J.C. (2004). *Risk management and error reduction in aviation maintenance*. Aldershot , U.K.: Ashgate Publishing ([Amazon.com](#)).
- D. Johnson W.B., Sian, I.B., and Watson, J. (2000). Measuring the impact of human factors interventions. SAE Meeting on Advances in Aviation Safety, Daytona Beach, Florida, April 11-13, 2000. ([Download Document](#)).

3 key references
plus slides





Operator's Manual
Human Factors
in Aviation Maintenance
Last update: 10/5/2005



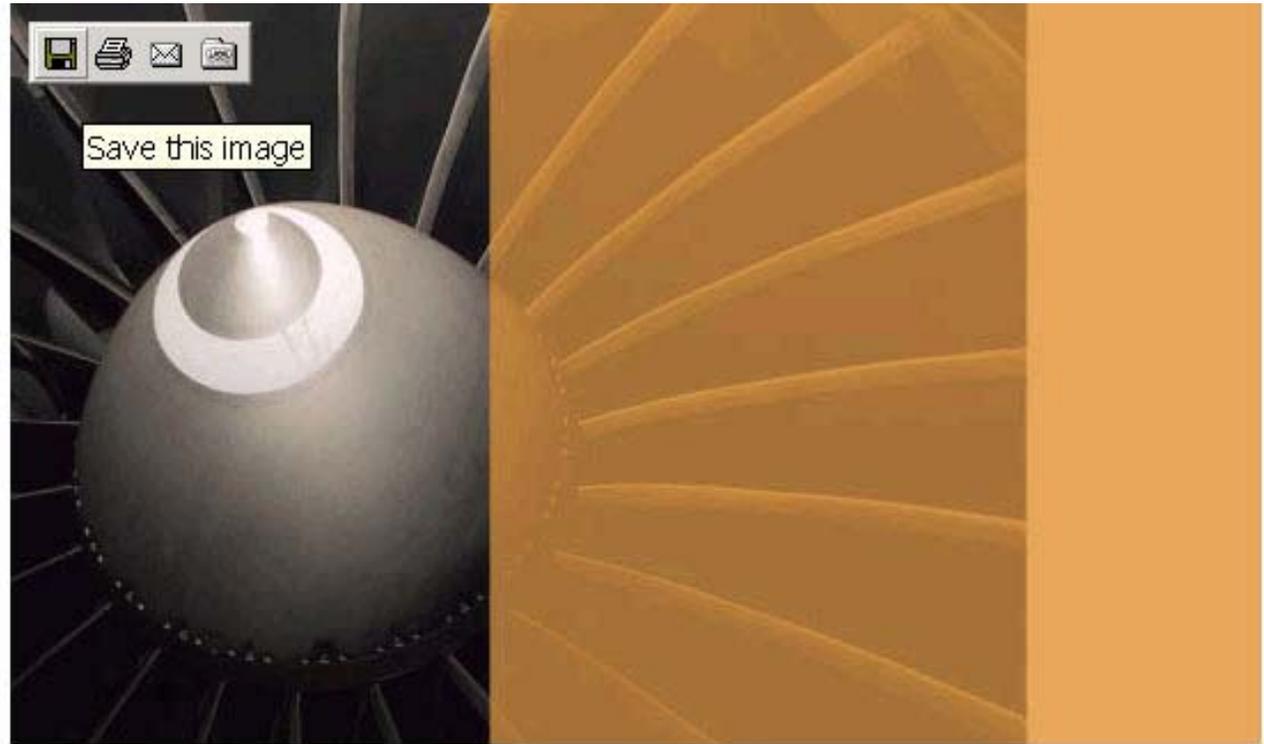
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- 3.0 Human Factors Training
- 4.0 Shift/Task Turnover
- 5.0 Fatigue Management
- 6.0 Sustaining & Justifying an HF Program

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www.hf.faa.gov/opsmanual



FAA HF Guidance for Part 145

- FAA AC 145-10, Ch. 3, §301(c)

- The FAA **concur**s with European Authorities in that human factors training related to maintenance practices would provide an additional margin of safety to the repair industry;
- A human factors training program should be related to **maintenance practices** where possible;

- At this time it is recommended. It is not an FAA regulation.
- EASA Certificate holder's must follow EASA rules



Language Error Study

1000 participants: Asia, Latin America, Europe and US.



Main Findings

- Language errors exist but typically found early
- High Accuracy everywhere: Non-native English speakers typically go slower but maintain accuracy

Main Recommendations

- Deliver more specialized language training.
- Provide and translation (full & partial).



- **International Conference (ATA)**



18th FAA/ATA International Symposium
Human Factors
Maintenance and Ramp Safety

- **Unmanned Aerial Systems (NASA)**



- **International Survey on HF in Maintenance (CAMI)**

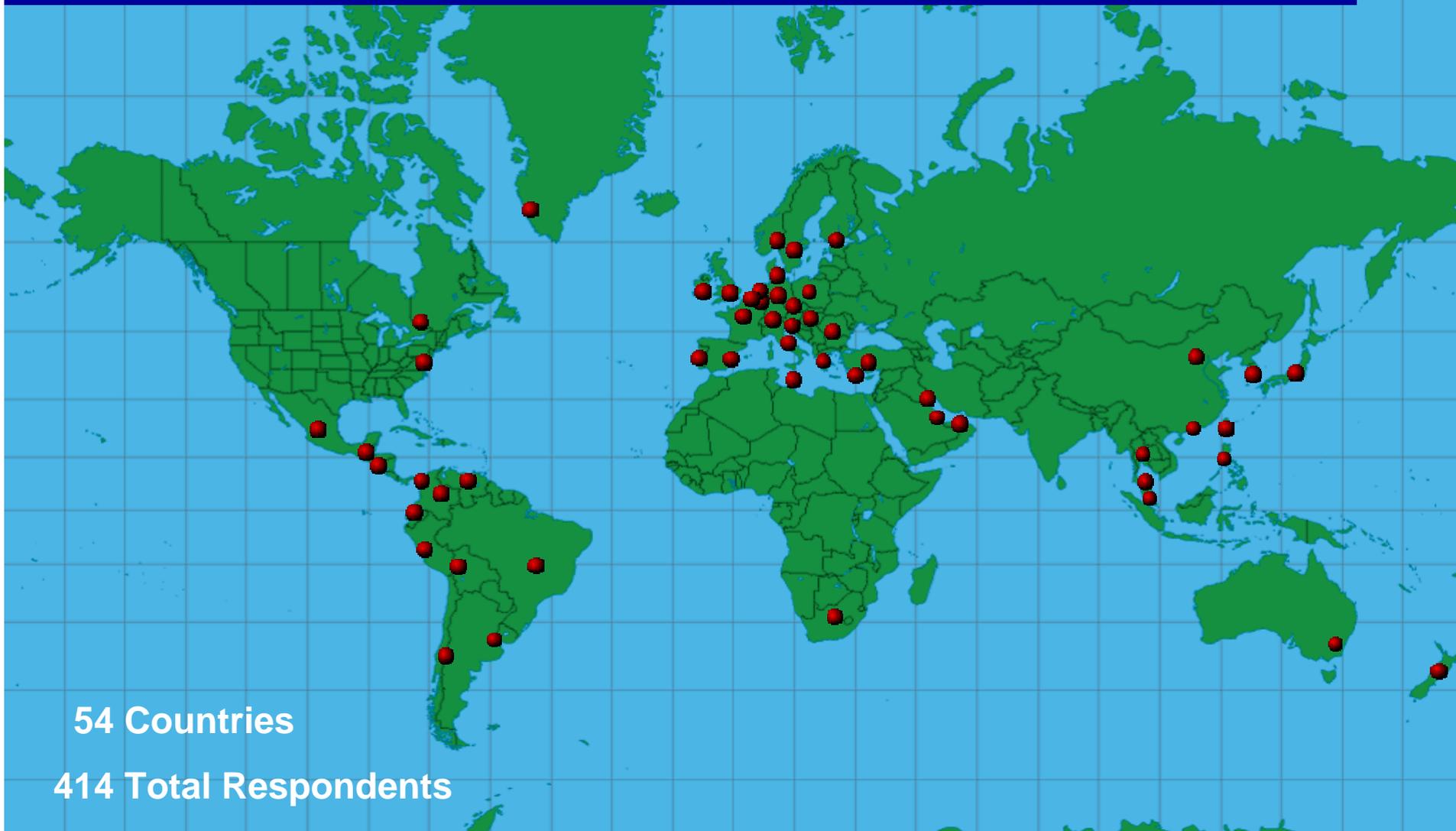


Survey Goals and Methods

- ❖ **Purpose:** Assess status of maintenance HF
- ❖ **Focus:** program support and motivation, organizational policies, fatigue management, error management, and training.
- ❖ **Distribution:** Online survey (80 items) 630 addresses.
- ❖ **Returns:** 414 respondents (66%) from 54 countries.
- ❖ **Experience:** 65% > 20 yrs. maintenance experience.



Respondent Representation



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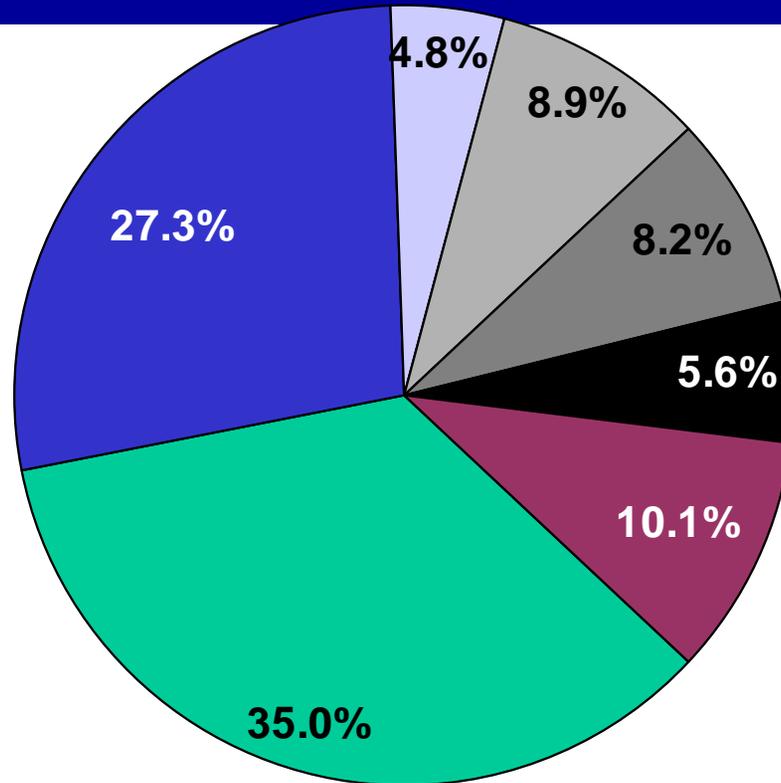


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Where do you work?



 **Air Maint**
 **GA/BIZ**
 **Other**

 **Repair Stn**
 **Mil/Govt**

 **Manufacturer**
 **School/Trn**



Regulatory Compliance

Which is the primary regulatory authority your maintenance operations are designed to be in compliance with? **N=404**

Civil Aviation Safety Authority (CASA) N=19	4.7%
European Aviation Safety Agency (EASA) N=95	23.5%
Federal Aviation Administration (FAA) N=182	45%
Transport Canada N=36	8.9%
Other National Aviation Authority N=72	17.8%

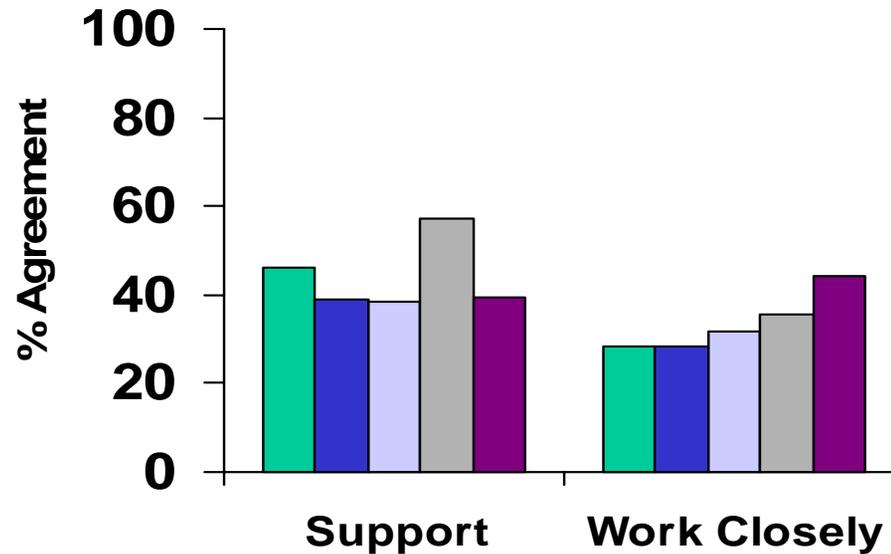


FAA has the fewest Human Factors requirements

Topic	ICAO	EASA	TC	FAA
HF for Initial Certification	Annex 1	145.A.30(e) incl AMC&GM 145.A.30(i)	CAR 573.06	No
Continuation Training for HF	Annex 6	145.A.35 (d)	CAR 573.06	Recommended in ACs
Error Management System	Guidance	145.A.60	CAR 1	Rec, 145.211
Fatigue Management System	Guidance	145.A.30(d) incl. AMC	Proposed, now awaiting consul.	Guidance in Tech Pubs 121.377
Accountable Executive	No	145.A.30	CAR 106	145
Published HF Guidance Materials	Doc 9683-AN/950	GM145.A.30 (e) &Part 66 Appendix I M9	TP 13459	AC120-72, Ops Manual, FAA Website
Documentation Reporting Requirement	Guidance	145.A.45	CAR 573.08	145.109 121.369
Safety Culture/Safety Management System	Under development Annex 6	145.A.65	CAR 573.30	Continuing Analysis and Surveillance System
Procedural Non-compliance	Guidance	145.A.65 (c)	CAR 571.05	ASAP
Planning of tasks, equipment, and spares	Guidance	145.A.47	No	145.109
Shift and task handover	Guidance	145.A.47	CAR 573.08	121.369 (b) 9 135.427(b) 9
Error capturing (duplicate inspections)	Guidance	145.A.65 (b)3	CAR 571.10	121.371



Regulatory Support and Close Work

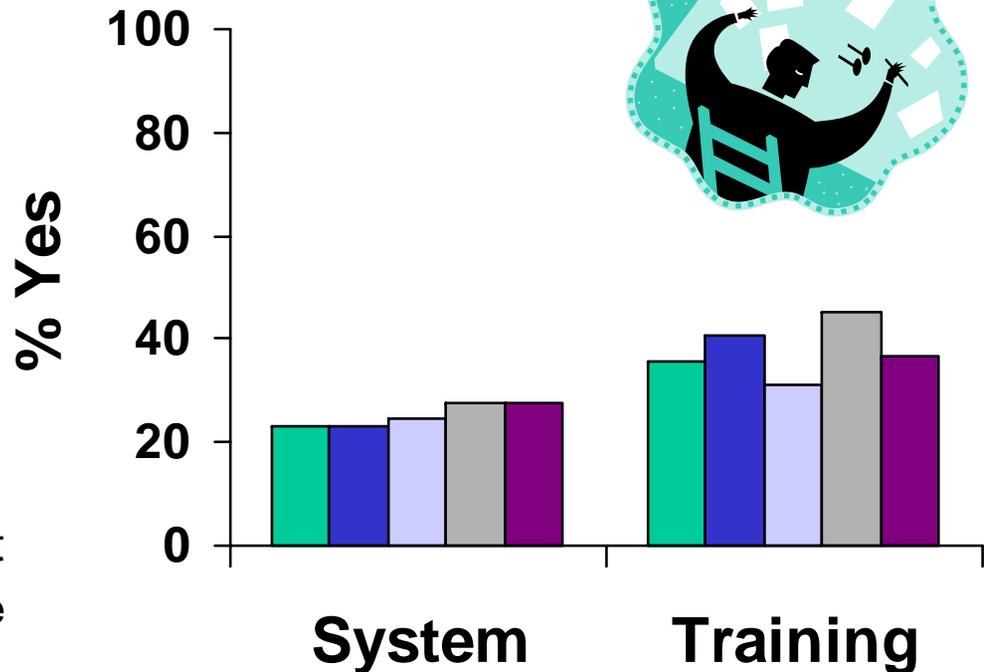


-  **CASA**
-  **EASA**
-  **FAA**
-  **Transport Canada**
-  **Other NAA**

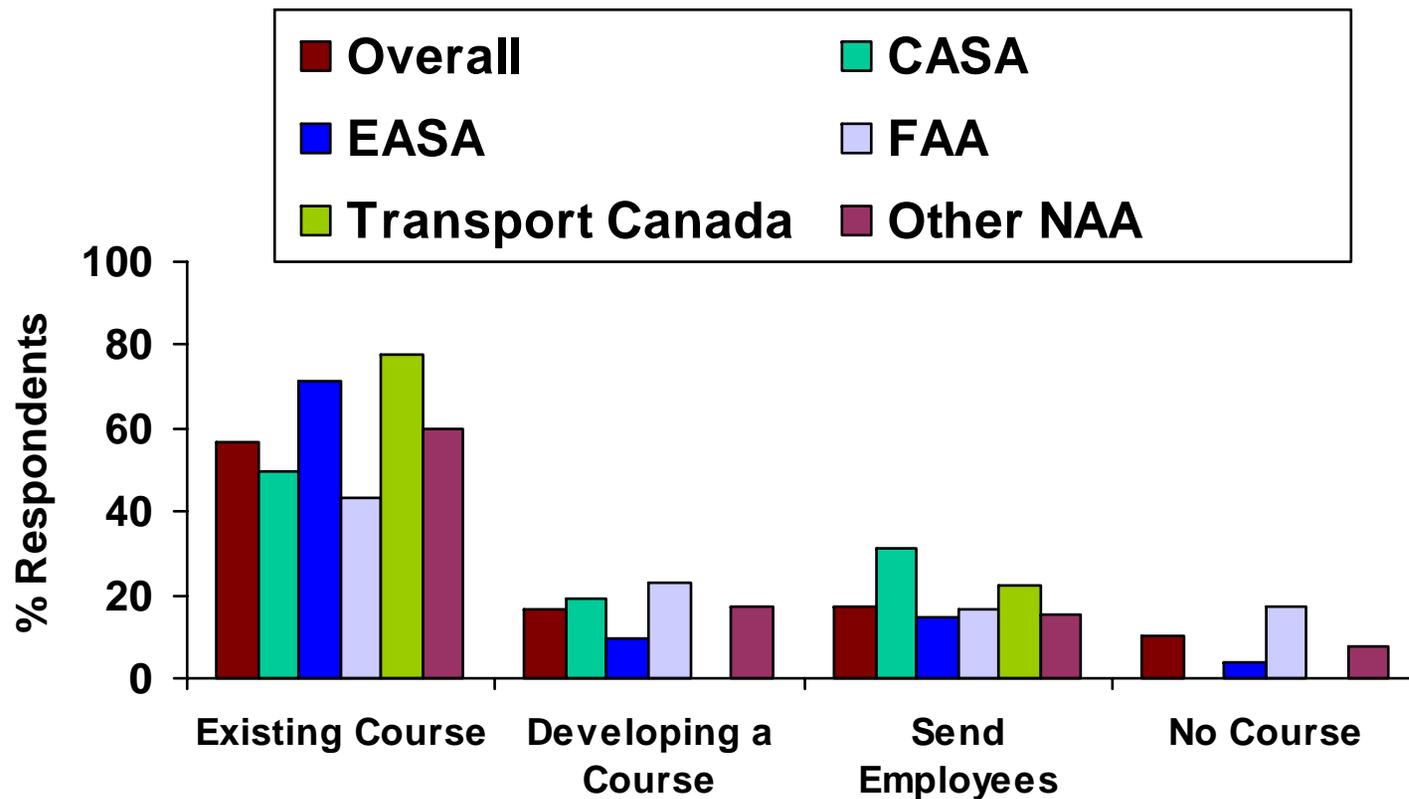


Fatigue is “Important” but few programs

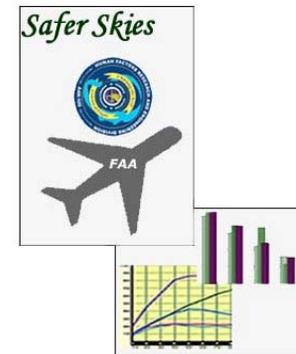
- ❖ Impact of fatigue was recognized by 82.1%.
- ❖ Fatigue Management System
 - ❖ Overall, 25% have a fatigue management system.
- ❖ Training on Fatigue Management
 - ❖ 35.9% provide training on fatigue management.



Transport Canada and EASA have HF Training



- **Web-Based Surveillance and Auditing Tool (WebSAT)**



Analyze Aircraft Maintenance Data
...Improve Airline Safety

Welcome to Login Screen

Username

Password

[Change Password](#)

[Forgot Password?](#)

- **Revised Training Course for FAA Inspectors**

2 Days  3 Days
Highly Revised!



Additional Selected 2006 Activity

- Rewrite of “*Human Factors Guide for Maintenance and Inspection.*”



- Revive “hfskyway.faa.gov”



- AFS Mx Human Factors Plan



Agenda

Describe an ideal HF Mx & Ramp Safety Conference

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Challenges

- **Maintenance HF Regulations: 25, 65, 121, 135,145, 147.**
- **Fatigue R&D? Guidance? Regulation?**
- **Advanced Technologies, VLJs, Rotorcraft, UAVs, Avionics, Commercial Space travel, Aging Aircraft,**
- **Ensuring Quality & Safety in all Maintenance Organizations**
- **General Aviation Maintenance HF**
- **SMS in Maintenance**



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Q&A (Time permitting)

Thank you

