

Parallel Session

Operational Evidence of Fatigue: Shiftwork Operations

Views of Maintenance Fatigue Based Mostly on FAA Empirical Studies

William B. Johnson, Ph.D.
Federal Aviation Administration

14:45 - 15:10

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William B. Johnson, Ph.D.
Biography

Dr. William Johnson is the FAA Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems. Joining FAA in 2004, he is the top FAA person responsible for R&D and technical programs related to human performance in maintenance/engineering. Prior to FAA Bill spent 25+ years as a Senior Executive and Scientist for Engineering Companies specializing in Technical Training and Human Factors.

He is an Aviation Maintenance Technician and a pilot for 40+ years. He earned his Ph.D. from the University of Illinois in 1980. Since then, he has published extensively on human factors and technical training in many industries. He has delivered hundreds of speeches in over 50 countries.

Views of Maintenance Fatigue

Based Mostly on Empirical Studies since 1998

Dr. William B. Johnson
Chief Scientific & Technical Advisor for
Human Factors in A/C Maintenance Systems

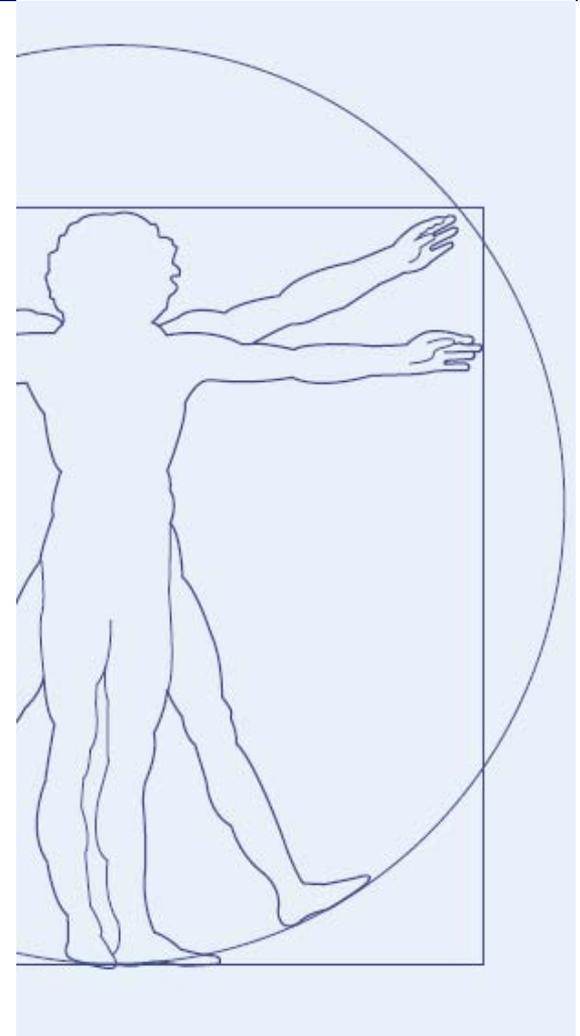


**Federal Aviation
Administration**



Presentation Method

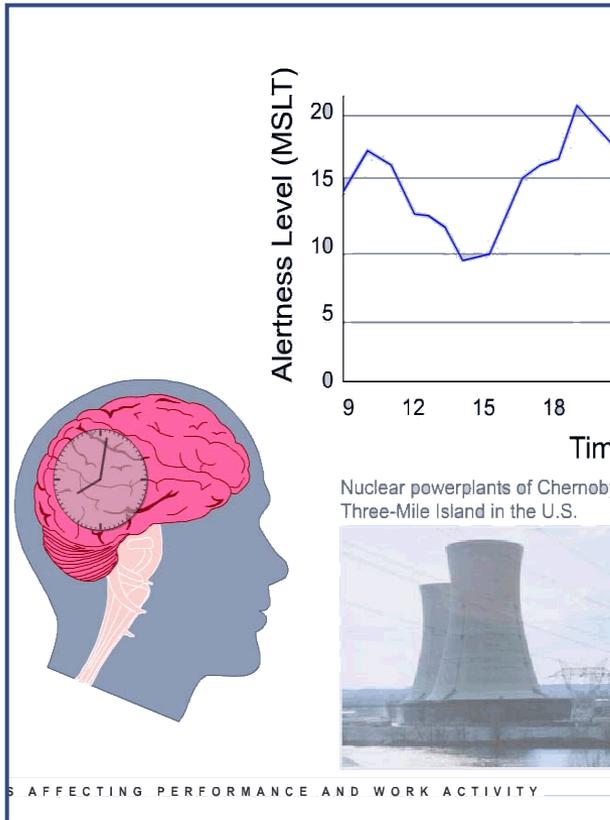
- State the facts about challenges in maintenance organizations
- Use published FAA results/reports
- Stimulate discussion and recommendations
- To remain a “messenger” of the data and to avoid extensive recommendations for action.....but..



4b

An Example of new FAA Fatigue Awareness

Fatigue Issues



Agenda

Survey (Sian and Watson, 1999)

Study of Working Conditions (Johnson, et al., 2001)

Industry HF Survey (Hackworth, et al., 2006)

FAA Inspector Survey (Hackworth, et al., 2007)

ASRS (1999 – '08) & Industry Comments (Johnson, 2008)



Fatigue Survey (Sian & Watson 1999)

STUDY OF FATIGUE FACTORS AFFECTING HUMAN PERFORMANCE IN AVIATION MAINTENANCE

46-item questionnaire via US Mail

518 US industry respondents



Hours of Work and Sleep

- Hours per week worked 49.4 SD 9.0
- Hours per day worked 8.5 SD 1.0
- 25% worked > 52 hours
- Hours of sleep (workday) 6.7 SD 1.1
- Hours of sleep (non-workday) 8.0 SD 1.3
- 25% slept < 6 hours during work nights
- No work hour difference between shifts

Probably need more rest !



Comments from 1999

“When younger, low pay requires you to be willing to work lots of overtime.. (I am thankful) I don't now have to rely on O.T.(16) to survive.....”

“There should be requirements for crew rest for maintenance folks. Working 16-24 hours is not safe for anyone.”

Duty hours are not a new issue !



Comments from 1999

“... I am a corporate maintenance technician and I am basically on call 24 hours a day....There has always been said and unsaid pressure to get the aircraft back in service..... Many times I've worked when I felt I was too fatigued.”

“The government has no business mandating work hours or schedules.”

Not everyone wants mandates !



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Fatigue Project (Johnson , et al 2001)

- Collected data at 3 carriers, 1 repair station, 7 locations, year-round
- About 125 significant participants.
 - 10,000+ Hours of MiniLogger data (**Temp, Light, Sound**)
 - 50,000+ Hours of Actiwatch data (**Sleep**)
- 600+ Questionnaire respondents
- Published reports on: <http://hfskyway.faa.gov>.



Sleep Situation measured in 2000

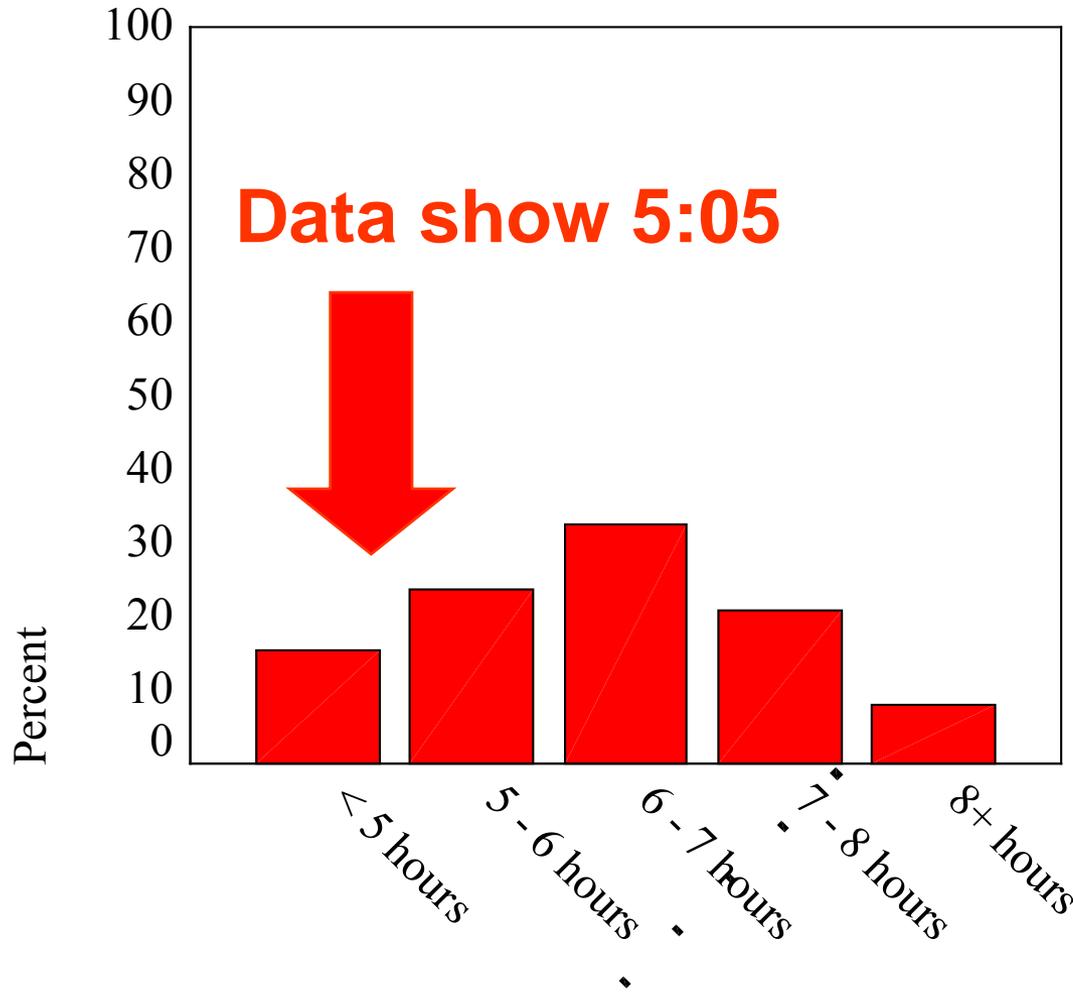
| Shift N(Number) | Minimum | Maximum | Mean |
|------------------------|----------------|----------------|-------------|
| Day (30) | 3:24 | 6:38 | 5:06 |
| Afternoon (19) | 2:40* | 6:31 | 5:04 |
| Grave (12) | 4:01 | 6:09 | 5:00 |

Average sleep was 5:05

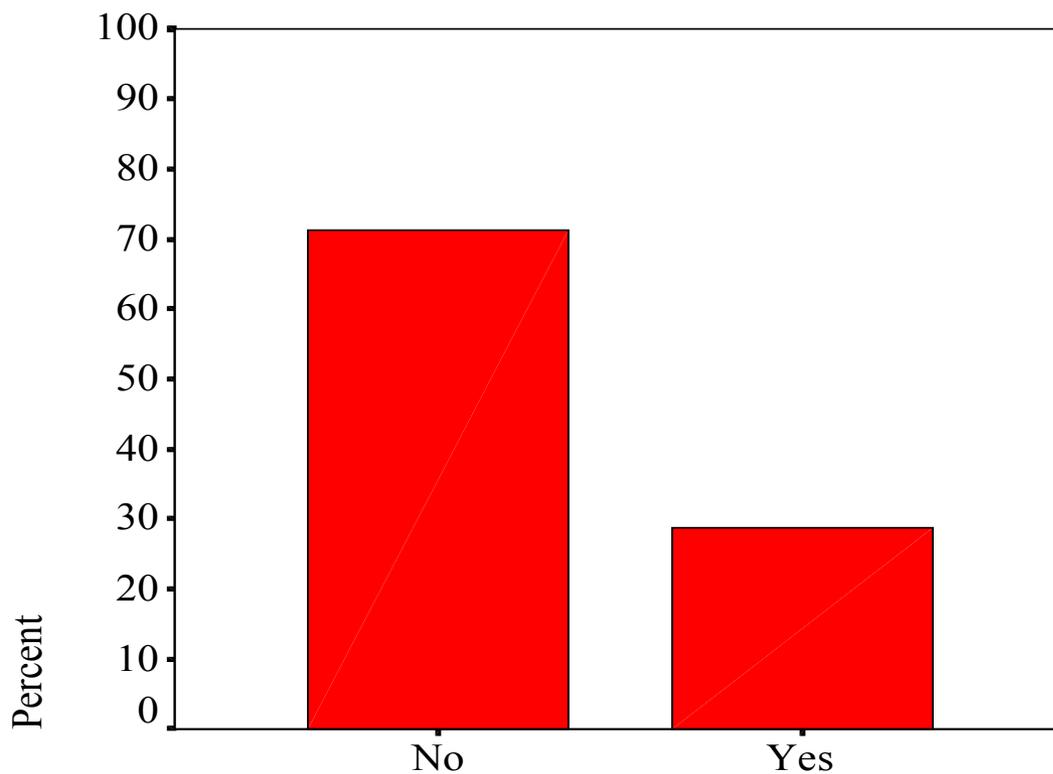
*Confirmed with participant when analyzing sleep data on out briefing



Mechanics Over Reported Sleep



Does Fatigue impact your work?



Agenda

Survey (Sian and Watson, 1999)

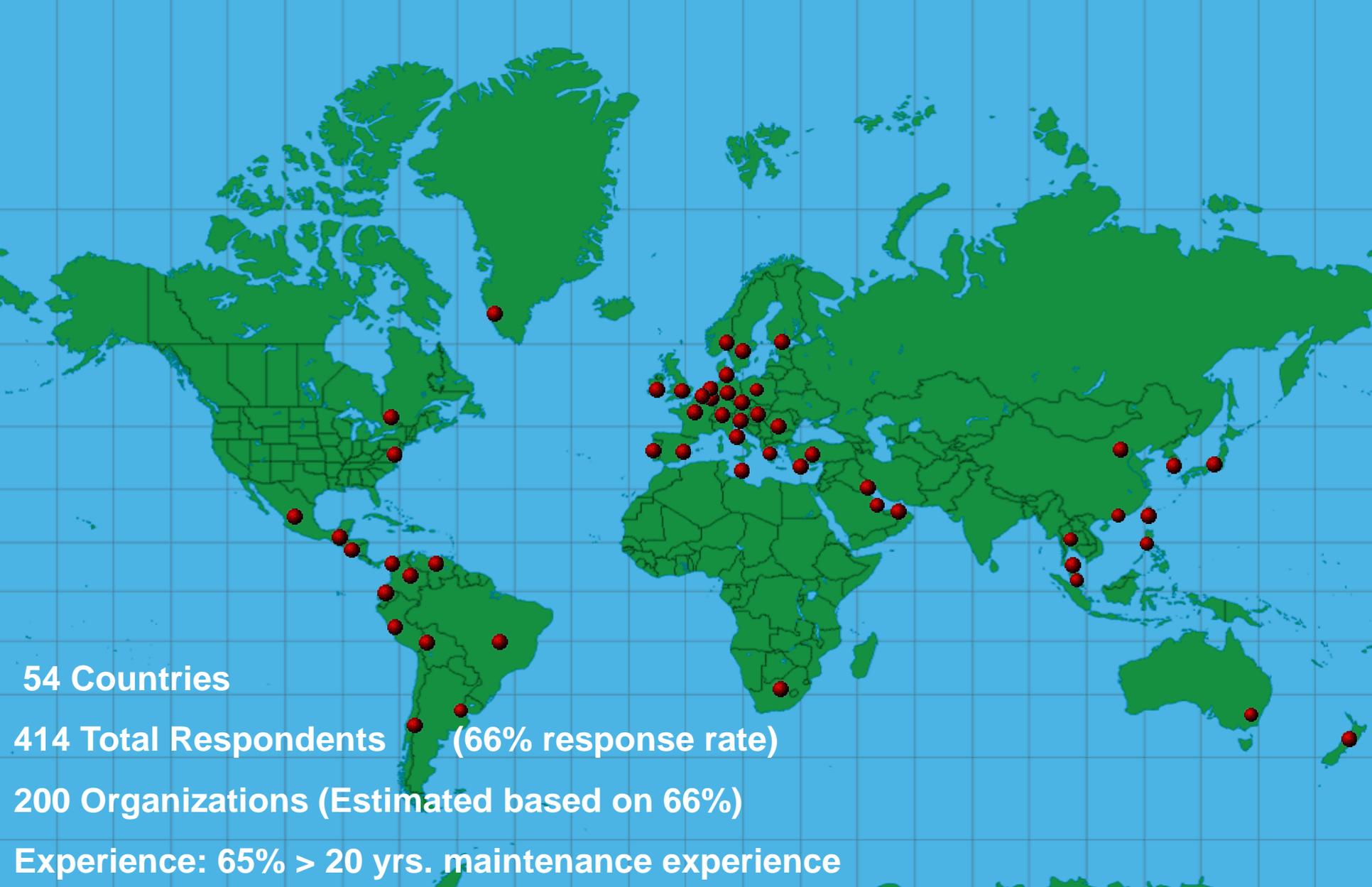
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54 Countries

414 Total Respondents (66% response rate)

200 Organizations (Estimated based on 66%)

Experience: 65% > 20 yrs. maintenance experience



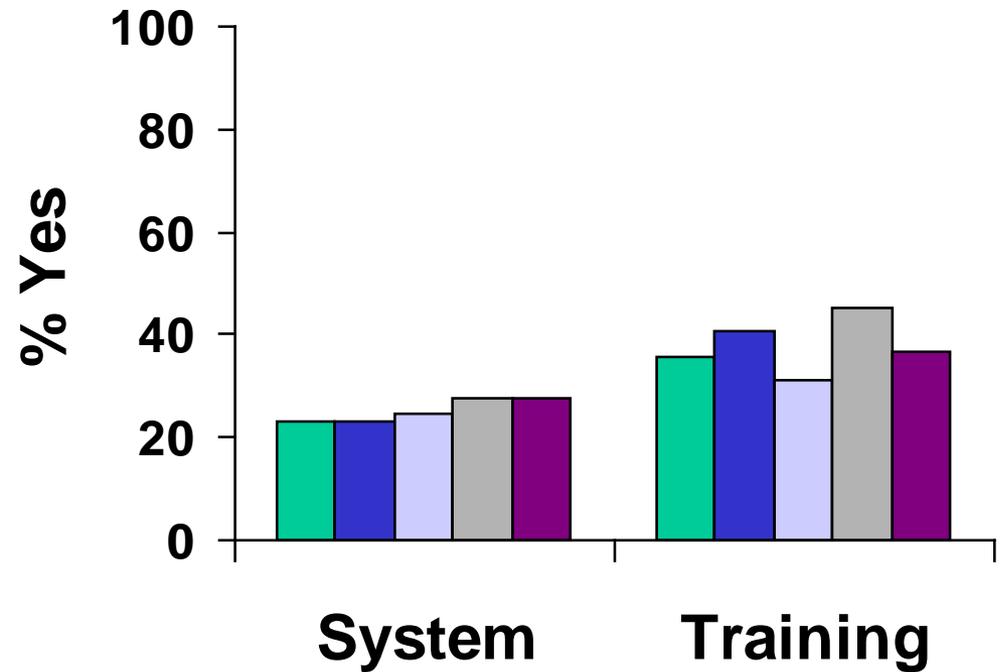
HF Program Elements: Fatigue Management

82% said fatigue was an issue.

25% had Fatigue Management Systems.

36% had Training on Fatigue Management

An opportunity for improvement!



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

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Who Responded?

2. This survey is aimed at Airworthiness Inspectors, supervisors, and managers. What is your Aviation Safety Inspector (ASI) area? *(Response required)*

n 897
897

| <u>Freq. n</u> | <u>%</u> | | <u>Freq. n</u> | <u>%</u> | |
|----------------|----------|------------------------------|----------------|----------|--|
| 254 | 28.3 | General Aviation Maintenance | 6 | 0.7 | Manufacturing Inspector |
| 302 | 33.7 | Air Carrier Maintenance | 18 | 2.0 | FAA Safety Team - Airworthiness |
| 100 | 11.2 | General Aviation Avionics | 4 | 0.5 | Aviation Cabin Safety Inspector - <i>(Not included in report)</i> |
| 133 | 14.8 | Air Carrier Avionics | | | |
| 6 | 0.7 | Certification | 74 | 8.3 | None of the above - <i>(Not included in report)</i> |

Includes only those respondents who indicated 'AFS' on item 1.

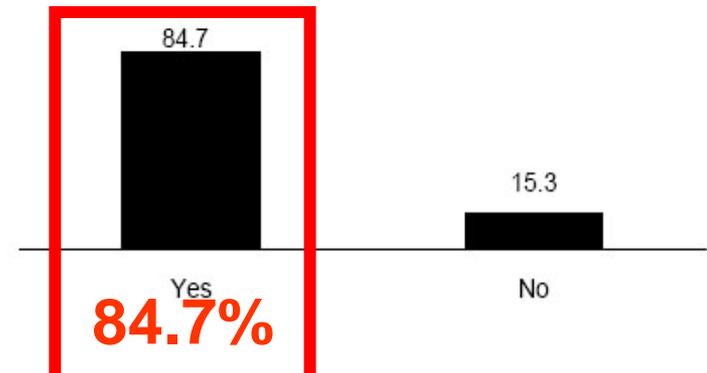


Are you in the Field?

8. Do you perform surveillance as part of your job? *(Response required)*

n 819

Response Distribution (%)



People who know what's happening in the field.

ASI Ranking of Operator Challenges

| ISSUE | Average on 5 points |
|---|----------------------------|
| Pressure | 3.09 |
| Complacency | 2.89 |
| Norms | 2.84 |
| Lack of resources | 2.74 |
| Failure to follow procedures | 2.73 |
| Distraction | 2.60 |
| Lack of awareness | 2.59 |
| Lack of communication | 2.58 |
| Lack of assertiveness | 2.53 |
| Stress | 2.50 |
|  Fatigue | 2.41 |
| Lack of knowledge | 2.34 |
| Lack of teamwork | 2.32 |

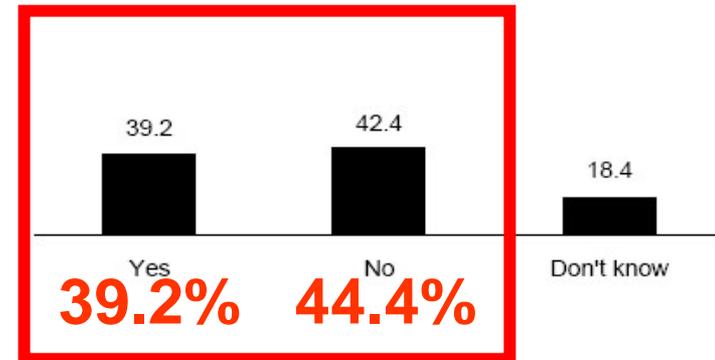


Fatigue and Duty Time

Section III. Fatigue

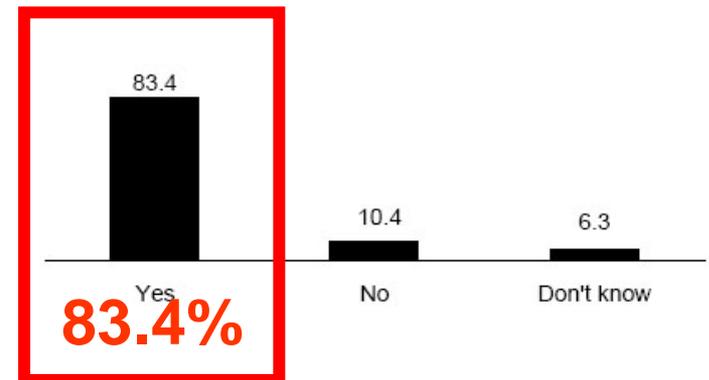
17. Do you think maintenance employee fatigue is a safety issue for the operators that you oversee?

n 674



43. Do you think that there should be a regulation regarding the length of duty time and rest for all maintenance personnel?

n 782

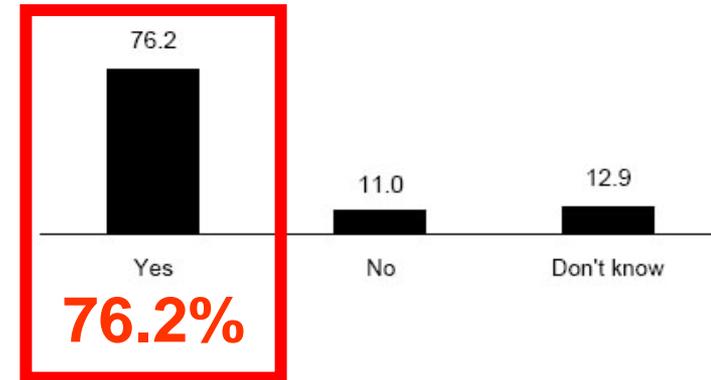


Regulatory issues on Human Factors?

Section II. Your Perceptions of Maintenance Human Factors

32. Should the FAA develop regulations that require Human Factors programs in maintenance?

n 794



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How many tales make truth?

- Mx has a lot to document.
- To document fatigue is not a requirement
- But there are a lot of stories out there
- Some question the validity and reliability of stories
- Stories should not be the primary driver for change but they should not be ignored.
- Here are but a few:



NASA ASRS Report (7175) (Two jobs)

“I HAD WORKED MY NORMAL SHIFT AT ANOTHER AVIATION COMPANY (13 HRS) AND STOPPED ON MY WAY HOME TO SEE WHAT THE STATUS OF THE FLEET WAS..... I LEFT AFTER 2 HRS..... I GOT HOME AT XE00 AFTER HAVING TO RUN SEVERAL OTHER SMALL ERRANDS. I WOKE BACK UP AT XI00 AND RETURNED TO THE HANGAR.”

Two work lives?



NASA ASRS Report (15/75) (Procedure Following?)

ASRS Synopsis – Pax Oxygen canister

Narrative (partial)

RECOVERING FROM A SEVERE COLD WITH LITTLE BIT OF SLEEP WITH ONLY 2 MECHS ON DUTY THAT DAY ... WITH AN ABNORMAL WORKLOAD ...

... I RUSHED TO PULL UP AND PRINT OUT THE MAINT MANUAL..., THE PRINTER WAS JAMMED, SO I SKIMMED THROUGH THE MAINT MANUAL ON THE COMPUTER SCREEN AND FOCUSED ON THE OPS CHK

Procedures or fatigue?



NASA ASRS Report (32/75) (Commuting?)

NASA Synopsis

A B737-300 TECHNICIAN RPTS INSTALLING AN ESCAPE SLIDE ON 2L DOOR WITHOUT INSPECTION AND REMOVING THE SAFETY PIN.

Narrative (partial)

....IN ADDITION, IT WAS MONDAY AND I COMMUTED FROM ZZZ1. I WAS UP MORE THAN 24 HRS. I WAS VERY **TIRED**. I DON'T RECALL CALLING INSPECTION OR REMOVING THE SAFETY PIN FROM THE SLIDE. I WORKED ON THE AIRPLANE ALONE.....

Fatigue awareness programs?



NASA ASRS Report (33/75) (3/30 days off)

NASA Synopsis: Wing mount improperly torqued

Narrative (partial)

“...but I BELIEVE THAT OCCURRENCE IS A RESULT OF FATIGUE AND STRESS. DURING THE PREVIOUS 7 DAYS, BOTH MYSELF AND THE OTHER TECHNICIAN HAD WORKED MANY LONG HRS. OVER THE PREVIOUS 30 DAYS I HAVE HAD 3 DAYS OFF...”

Scheduling and Awareness?



NASA ASRS Report (33/75) (More than fatigue?)

ASRS Synopsis

A SHOP TECHNICIAN RPTS FAILING TO CALIBRATE THE ESCAPE SLIDE BOTTLE PRESSURE TEST Narrative (partial)

“...I WAS VERY TIRED, AND UNDER A LOT OF STRESS. MY 26 YR OLD SON HAD JUST HAD HIS SECOND CANCER SURGERY AND MY SLEEP PATTERN WAS NOT GOOD. HE WAS IN THE HOSPITAL, RELEASED, AND THEN READMITTED....”

Awareness of Psych Fitness for Duty?



NASA ASRS Report (37/75) (Wake-up Call!)

Narrative (Partial)

“...I FEEL THAT A LACK OF SLEEP DISTURBED ME FROM GIVING 100% ATTN TO DETAIL. LACK OF SLEEP IS DUE TO INAPPROPRIATE UTILIZATION OF PERSONAL TIME OFF AND NOTHING TO DO WITH WORKING CONDITIONS OTHER THAN THIRD SHIFT SCHEDULES. RESPECTING THE FACT THAT MORE SLEEP IS NEEDED, BEING AWARE WHEN I HAVE NOT HAD ENOUGH SLEEP ARE THE FACTORS TO KEEP ME FROM REPEATING THIS MISTAKE AGAIN...”

Fatigue education?

NASA ASRS Reports (Misc.)

MY ONLY EXPLANATION IS I HAD A HEAD COLD FOR THE PAST 3 DAYS AND WAS FEELING TIRED. (52/75)

NUMEROUS HRS WERE WORKED BY THE 3 OF US, 19 HRS PER DAY FOR 3 DAYS PERSONALLY..... I HAVE SUBMITTED A CHANGE TO COMPANY SUGGESTING THE SPACER BE AN RII ITEM. (53/75)

FATIGUE WAS A FACTOR, THE INITIAL WORK WAS COMPLETED AS I WENT INTO THE 16TH HR OF MY SHIFT (64/75)

FATIGUE PLAYED A ROLE AS I HAD NOT SLEPT PRIOR TO THIS EVENT FOR A PERIOD OF TIME APCHING 22 HRS (71/75)



Industry Comments (It happens)

“I have been a Lead Mechanic for over 25 years for the airlines. Have I ever worked tired when I shouldn't have or seen others who worked tired when they shouldn't have? Yes. Do other mechanics, leads and management know about it? Yes. Have mistakes been made due to fatigue? Yes. Can I give you dates, times and specific examples? No. When errors are made we catch them and repair them and press on with the job. We don't document them. We simply fix them.”

Reality? We can address it!



Industry Comments (Misc)

“The FAA is now just seeing there is a problem with mechanic duty time. I guess there are miracles...”

“We need regulations for duty times like pilots have.”



Summary

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Data driven summary opportunities

- “Houston we have a problem” ... Really, we have an opportunity to ensure continuing safety.”
- There is not consensus on solutions
- Voluntary reporting is extremely helpful
- Awareness and education programs have promise
- Manage fatigue as we manage safety.... by improving the data.



FAA-ATA Conference

2008 symposium



Human Factors
Maintenance and Ramp Safety

Sept 3-4, 2008
Orlando, Florida

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Primary References

Hackworth, C.A., Banks, J.O., Holcomb, K.A., Johnson, W.B., Hiles, J.J. (2007). *Aviation Safety Inspectors' (ASIs) Maintenance Human Factors Survey*, (Report No. TBD). Oklahoma City, OK: FAA Civil Aerospace Medical Institute.

Hackworth, H., Holcomb, K., Dennis, M., Goldman, S., Bates, C., Schroeder, D., Johnson, W. (2007). *An International Survey of Maintenance Human Factors Programs* (Report No. 07/25). Oklahoma City, OK: FAA Civil Aerospace Medical Institute.

Johnson, W.B., Mason, F., Hall, S., and Watson, J (2001). *Evaluation of Aviation Maintenance Working Environments, Fatigue, and Human Performance*. Washington, DC: Federal Aviation Administration Office of Aviation Medicine. <http://hfskyway.faa.gov>.

Sian, B. and Watson, J. (1999). *Study of Fatigue Factors Affecting Human Performance in Aviation Maintenance*. Washington, DC: FAA Office of Aviation Medicine. <http://hfskyway.faa.gov> .

NASA ASRS Data, Searching maintenance and fatigue submissions from 1999-2008.