• Definitions

• Contributing Factors
  – Individual
  – Medical
  – Environmental
  – Operational

• Mitigation Strategies

• Operational Guidance & Resources
Definition - FAA

• Characterized by increased discomfort
• Lessened capacity for work
• Reduced efficiency of accomplishment
• Loss of capacity to respond to stimulation
• Usually accompanied by feeling of weariness and tiredness

“Fatigue in Aviation” FAA Pilot Safety Brochure Medical Facts for Pilots, Pub # OK-07-193
Definition

- Weariness from bodily or mental exertion
- The decreased capacity or complete inability of an organism, an organ, or a part to function normally because of excessive stimulation or prolonged exertion

- Stedman’s Medical Dictionary 2002
Perspectives on Fatigue

- **Pilots** –
  “Insidious, yet very dangerous, risk factor in all types of aviation operations.”

- **Bosses** –
  “Sleep is for under-achievers.”

- **Schedulers** –
  “You can get all the sleep you need when you die.”
Dangers of Fatigue

• Associated with Accidents
• Reduced Safety Margins
• Reduced Operational Efficiencies

• Individual is not able to reliably detect or judge degree of impairment due to fatigue!
Fatigue Types

- Transient - brought on by extreme sleep restriction or extended hours awake (1-2 days)

- Cumulative - repeated mild sleep restriction or extended hours awake across a series of days

- Circadian - the reduced performance during nighttime hours, particularly during an individual’s window of circadian low (WOCL) (typically between 2 a.m. and 6 a.m.)

FAA NPRM Docket No. FAA-2009-1093; Notice No. 10-11, Federal Register 16 Sep 2010
Flightcrew Member Duty and Rest Requirements
Circadian Issues

• Circadian cycles
  – Highs 0900 – 1100 & 2100 – 2300
  – Lows 0300 – 0500 & 1500 – 1700

• External & Internal factors

• Natural cycle 25 hours +/- 2 hours
  – Darkness
  – Melatonin / Adenosine
  – Exercise
Circadian Desynchrony

- Jet lag” - non-geek definition
- Occurs when natural body clock out of synch with local clock

- Affects:
  - Sleep cycle
  - Memory, critical thought, reaction time
  - Mood, energy level
  - Digestion, blood pressure, others
Sleep Architecture

- Stage 1 – light sleep, movement
- Stage 2 – light sleep, eyes stop
- Stage 3 – deep sleep, slow waves
- Stage 4 – deep sleep, all slow waves
- REM - Dreams, mental recovery, no movement but brain very active
Sleep Architecture

- 90 minute cycles – lengthening
- REM reduced with aging
- Deep sleep – rejuvenating
- REM sleep – learning, innovation
- Physical necessity – Rat studies
  - Routine sleep Live 2-3 years
  - No REM Sleep Live 5 weeks
  - No sleep Live 2 weeks
You Know It When You See It
Contributing Factors - Individual

- Personal Sleep Needs (8 +/- 2 hours)
- Pre-operational sleep opportunities
- Physical Conditioning
- Diet
- Aging
- Alcohol
- Outside stressors / activities
- Smoking
Contributing Factors - Medical

- Sleep Disorders
  - Sleep Apnea, Restless Legs, Narcolepsy
- Mental Distress
  - Depression, Anxiety, PTSD
- Pulmonary (Lung Diseases)
  - Asthma, COPD, Exposures (Job & Hobby)
- Heart Disease
  - Atrial Fib, Heart Attack, Myopathy, Valves
Sleep Apnea

- Common condition – 4 -7% of adults
- Severe medical consequences
  - Blood pressure, stroke, heart disease
- Sleep disturbances
- Hypoxia
- Lack of REM sleep

- FAA implications
Contributing Factors - Medical

- **Hypoxia**
  - Anemia, Smoking, Stagnation, DVT/PE

- **Chronic diseases**
  - CFS, Arthritis, Hepatitis, Diabetes, Kidney
  - Medications
    - Allergies, Pain, Caffeine, Heart, Stimulants

- **Others**
  - Obesity, HIV, Supplements, Hydration, Flu
Contributing Factors - Environment

- Noise
- Vibration
- Humidity
- Hypoxia
- Lighting
- Temperature
- Nutrition
Contributing Factors - Operations

- SCHEDULING, SCHEDULING…..
- Number of Terminal Operations
- Aircraft Rest Facilities
- Ground Rest Facilities
- Automation – Cockpit and Ground
- Cockpit Napping
- Cockpit Comfort
- Many, many others…….
Fatigue Symptoms

- Decreased alertness (missed radio calls, checklist items, missed altitudes, procedures)
- Difficulty remembering
- Reduced attention span/concentration
- Slowed reactions
- Ineffective communications
Fatigue Symptoms

- Irritable / moody
- Feeling tired / Inertia
- Muscle stiffness / soreness
- Yawning
- Nodding off
- Missing last few seconds – “lights on…”
- Poor decision making
Micro-Sleep

• Causes - Exhaustion, sleep deprivation, boredom, hypnosis, narcolepsy
• Lasts 1 -30 Sec
• Rapid onset sleep type EEG (theta waves)
• Individual unaware many times
• Danger in lack of awareness and repeated episodes
Mitigation Strategies - Pilot

• Two good nights sleep pre-flight
two nights of 8 hours to make up for acute fatigue
• Avoid depressive medications
• Minimize pre-flight physical exertion
• Sunglasses
• Reduce heat / sun exposure
• Don’t Smoke
Mitigation Strategies – Pilot

- Consider caffeine if dependent – strategic use
  - Enough time to work
  - Enough time to clear system before rest
- Eating
  - Frequent small amounts
  - Proteins and complex carbohydrates
  - Not 2-3 hours before critical phase of flight
  - Hydration (sports drinks)
Mitigation Strategies – Pilot

• Oxygen
• Monitor radio comm / make a call
• Pay attention in high risk times
  1500-1700, 0200 - 0600
• Strategic Napping
  – 25 - 40 minute nap
  – Sleep inertia – 2 hour cycles
• Stretching – DVT prevention
Mitigation Strategies – Hotel

• Exercise (not two hours before sleep time)
• Rest during home circadian lows - short
• Sleep Environment –
  – consistent & comfortable
  – Secure and sacrosanct
  – Ear plugs, eye shade, ? iPod
• Don’t fight wakefulness
Fatigue Mitigation - Drugs

- Caffeine
- Melatonin – take at desired bedtime
  - Ground trial – paradoxical effect 10%
- Sleep aids – Ambien, Lunesta, Rozerem, Sonata
  - 12-24 hour restriction – max 2 days per week
- Sleep aids – OTC
  - 12 (30) hour restriction – hangover effect
- Alertness meds – not legal
Fatigue Mitigation - Operational

- **Circadian Issues**
  - Adjust departure / land times – Avoid WOCL
  - Augment crew for long, many or WOCL flights
  - Duty Time is as important as Flight Time
- **Flight Planning Day Prior**
- **Pre-position aircraft and crew**
- **Build in Rest Times**

Single pilot operations much more difficult!
Fatigue Detection – Future

- Real-time Non-invasive Monitoring
  - EEG
  - Eye Movement
  - Facial recognition
  - Wrist Activiography

- Fatigue Prediction Models
  - SAFE – System for Aircrew Fatigue Evaluation
  - SAFTE – Sleep, Activity & Fatigue Task Effectiveness
  - FAST – Fatigue Avoidance Scheduling Tool
• Fatigue Countermeasures in Aviation
  – Caldwell et al, AsMA Aerospace Human Factors
  – Aviat Space Environ Med 2009; 80: 29-59

• Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation
  – Flight Safety Foundation Feb 1997

• Flightcrew Member Duty and Rest Requirements
  – Docket No. FAA-2009-1093; Notice No. 10-11
  – 16 Sep 2010 (Revise as final rule is announced)
Resources

• Your Guide to Healthy Sleep – NIH

• Lessons From the Dawn of ULR Flight
  – FSF Flight Safety Digest Aug-Sep 2005

• Aircrew Fatigue: A Review of Research Undertaken on Behalf of the UK CAA
  – CAA paper 2005/04 www.caa.co.uk

• Aerospace Medicine Association www.asma.org
Summary

- Physiology - Impossible to fool, variable
- Possible to maximize physiology to your benefit
- Pharmacology can help (and hurt)
- Planning improves performance
- Prevention is best strategy

Get Some Rest! (after the presentation)
Questions

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