



# Human Factors In Aircraft Maintenance

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# What is Human Factors?

- ✈️ 70-80% of aircraft accidents are due to human factors – JAA, May 2001
- ✈️ Maintenance contributed to 15% of commercial jet accidents – Boeing, 1995

# Maintenance Human Factors

- ✈️ 20-30% of in-flight engine shutdowns & 50% of delays/cancellations are caused by human error – Boeing, 1997
- ✈️ 48,800 non-airworthy aircraft are dispatched each year as a result of maintenance error – Marx, 1998
- ✈️ Ramp accidents cost over \$2 billion annually – Ramp Safety Vol.11:3

# Dollars & “Sense”

- ✈️ Avg. cost of an in-flight engine shutdown is \$500,000
- ✈️ Avg. cost of a flight cancellation is \$50,000
- ✈️ Avg. cost of a return to gate is \$15,000
- ✈️ Avg. ground damage incident costs \$70,000
- ✈️ One airline estimates \$75-\$100 million/year is lost
- ✈️ Airline Transport Association estimates that ground damage costs \$850 million/yr

# Accidents w/ Maintenance Error

- ✈ American Airlines Flight 191 – 1979
- ✈ Aloha Airlines Flight 243 – 1988
- ✈ United Flight 232 – 1989
- ✈ Atlantic Southeast Airlines (ASA) Flight 532 – 1995
- ✈ Air Alaska Flight 261 – 2000
- ✈ Paul Wellstone (B100) crash – 2002
- ✈ Spectrum Aeronautical LLC - 2006

# General & Corporate Aviation

- Little to no data is available
  - Huge industry push yet we get pushed aside
- With little focus we have to work harder
- Safety Managers will have to adapt and adopt

# The Human Element (“Hu”)

✈️ “We’re only human...”

✈️ We *\*will\** make mistakes...

✈️ The key is to minimize errors, but how?

# The “Dirty Dozen”

- ✈ Complacency
- ✈ Lack of Assertiveness
- ✈ Distraction
- ✈ Lack of Awareness
- ✈ Fatigue
- ✈ Lack of Communication
- ✈ Norms
- ✈ Lack of Knowledge
- ✈ Pressure
- ✈ Lack of Resources
- ✈ Stress
- ✈ Lack of Teamwork



# Dirty Dozen - Complacency

✈️ "I don't need to go get the tech data; I've done this a hundred times..."

✈️ "No need to pull that panel. Last time I checked that linkage had plenty of grease..."

✈️ "I've been an aircraft mechanic for over 25 years; I know what I'm doing..."

# Dirty Dozen - Complacency

## ✈️ Safety Nets

- ✈️ Always follow checklist(s) &/or squawk cards
- ✈️ Never work from memory
- ✈️ Be sure to vary your routine periodically
- ✈️ Be aware of the dangers of complacency

# Dirty Dozen - Distraction

- ✈ Phone calls
- ✈ Personal Issues
- ✈ Water Cooler Talk

# Dirty Dozen - Distraction

## ✈️ Safety Nets

- ✈️ Use a detailed checklist
- ✈️ Always finish the task
- ✈️ Double-inspect the work
- ✈️ Use torque seal &/or safety wire
- ✈️ Record or tag uncompleted work
- ✈️ When you return to the task, always go back three (3) steps

# Dirty Dozen – Fatigue

## ✈️ What is Fatigue?

✈️ The body's normal reaction to a physical or mental stress of a prolonged duration

✈️ There are two types

✈️ Acute – short duration; cured with good night's sleep

✈️ Chronic – occurs over a long period of time; long recovery

# Dirty Dozen – Fatigue

## ✈ Causes of Fatigue

- ✈ Long hours of labor (any type)
- ✈ High-intensity stress
- ✈ Large temperature variations
- ✈ Noise – above 80db for long duration
- ✈ Sufficient intensity vibration for long periods
- ✈ **STRONG** lighting

# Dirty Dozen – Fatigue

## ✈ Symptoms of Fatigue

- ✈ Enhanced stimulus required in order to respond
- ✈ Attention reduced
- ✈ Memory diminished
- ✈ “Withdrawn” mood
- ✈ Circadian Rhythm inconsistencies

# Dirty Dozen - Norms

✈️ "I don't care how you did it there, we've done it *this* way for years!"

✈️ Outdated/inadequate company policies



# Dirty Dozen – Norms

- ✈️ What are “Norms” exactly?
  - ✈️ The way of doing business that’s not approved, but it’s been done locally for so long that it’s now a “Norm”
  - ✈️ ALWAYS work IAW the appropriate tech data, or if needed, have the manual revised
  - ✈️ Be aware that “Norms” do not make it right

# Dirty Dozen – Pressure

- ✈️ “Get it to the gate!!!”
- ✈️ Too tightly scheduled deadlines
- ✈️ Flat-rated Work Orders that maybe should have been rated

# Dirty Dozen – Pressure

## ✈️ Safety Nets

✈️ Stop! Assess the situation

✈️ Look at the situation rationally

✈️ Can I safely do the job on time?

✈️ Have I voiced my concerns clearly?

✈️ What is the worst thing that can happen to me?

✈️ Listen to your rational mind

✈️ Has this happened before?

✈️ Act

✈️ Speak up – ask for help or more time

# Dirty Dozen - Stress

✈ Personal issues

✈ Weather concerns

✈ Wanting that “atta-boy” for the boss

# Dirty Dozen - Stress

## ✈️ How to Manage

- ✈️ If you do not manage stress, it will gladly manage you
- ✈️ Stop burning up emotional energy
- ✈️ Look rationally at the problem
  - ✈️ Cure the cause, not the symptom
- ✈️ Listen to your rational, not your emotional, mind
- ✈️ Act – once you have a plan, go for it

# Dirty Dozen - Stress

## ✈️ Other Stress Helpers

- ✈️ Be sure the solution starts with "I"
- ✈️ Be realistic and practical
- ✈️ Take a break
- ✈️ Talk to someone who is not emotionally involved with the situation
- ✈️ Don't expect miracles, just keep trying

# Dirty Dozen – Lack of Assertiveness

- ✈️ “Only do what’s expected of me and that’s it... Not a movement more.”
- ✈️ Not researching all applicable technical data
- ✈️ Not following technical data to the “t”.

# Dirty Dozen – Lack of Assertiveness

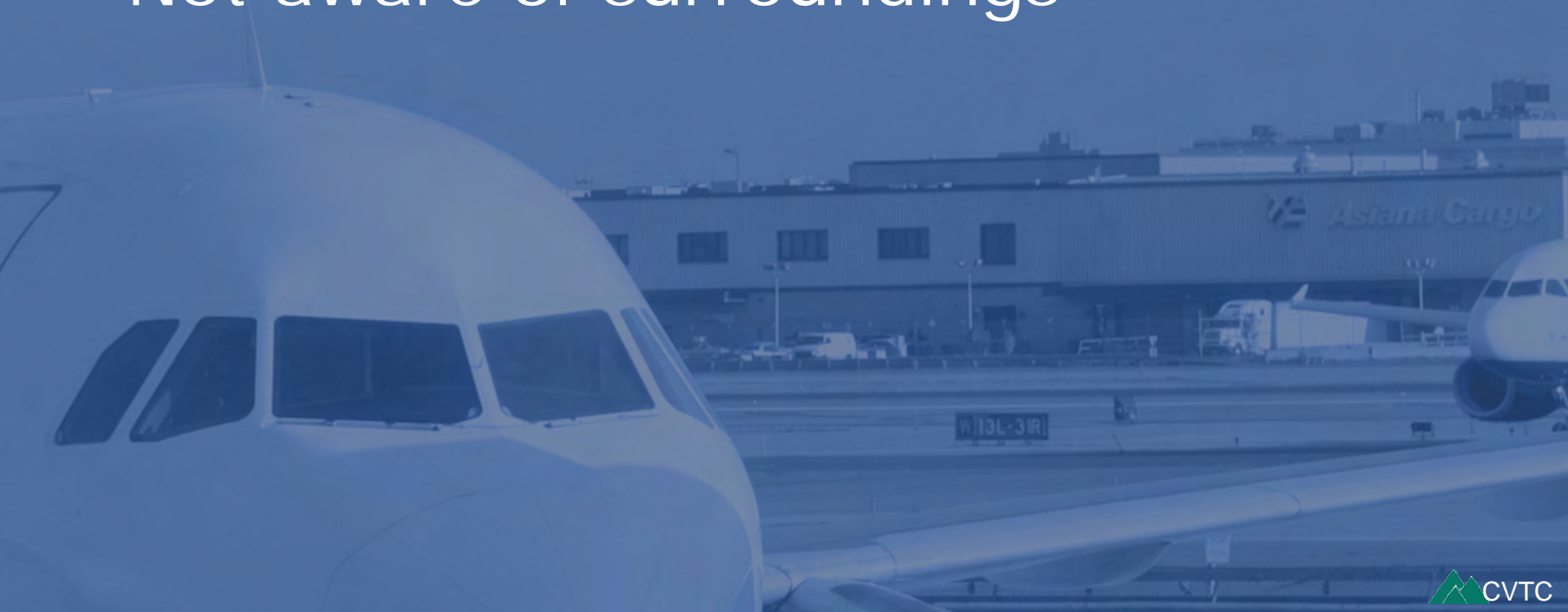
## ✈️ Safety Nets

- ✈️ Record all the work you do in the logbook, but only sign for that which is serviceable
- ✈️ Refuse to compromise your standards



# Dirty Dozen – Lack of Awareness

- ✈ Not aware of technical data revision
- ✈ Not aware of surroundings



# Dirty Dozen – Lack of Awareness

## ✈️ Safety Nets

### ✈️ THINK

✈️ What could occur in the event of an accident?

### ✈️ CHECK

✈️ Will your work conflict with a previous or existing repair &/or modification?

### ✈️ ASK

✈️ See if anyone else can spot a problem you overlooked

# Dirty Dozen – Lack of Communication

- ✈️ Either technician to technician
- ✈️ Management to hangar
- ✈️ Inspection Department to Maintenance crew(s)

# Dirty Dozen – Lack of Communication

## ✈️ Good Communication Tips

✈️ You have:

✈️ Two ears

✈️ Two eyes

✈️ One mouth

✈️ Use them in that order!

# Dirty Dozen – Lack of Communication

## ✈️ To Improve Communication

- ✈️ Learn to Listen

## ✈️ Do NOT

- ✈️ Debate

- ✈️ Detour

- ✈️ Pre-plan

- ✈️ Tune-out

## ✈️ Do

- ✈️ Ask questions

- ✈️ Paraphrase

- ✈️ Make eye contact

- ✈️ Use positive body language

# Dirty Dozen – Lack of Knowledge

✈️ "Am I experienced for this task?"

✈️ "Do I have all of the appropriate tech data?"

✈️ Aware of FAR's

# Dirty Dozen – Lack of Knowledge

## ✈️ Safety Nets

- ✈️ Obtain school training on type, model, etc
- ✈️ Get supervised on-the-job training
- ✈️ Use current technical manuals
- ✈️ Tech Reps &/or Manufacturer Reps are there for a purpose – use them!

# Dirty Dozen – Lack of Resources

- ✈ Is the appropriate tech data available?
- ✈ "Do I have the proper tools and equipment to perform the task?"



# Dirty Dozen – Lack of Resources

## ✈️ Safety Nets

- ✈️ Check all suspect areas at the beginning of all inspections and AOG the required parts
- ✈️ Order & stock parts before they're required
- ✈️ Know your sources
  - ✈️ Arrange for pooling &/or loaning
- ✈️ Maintain aircraft to highest standard

# Dirty Dozen – Lack of Teamwork

✈️ Is this a task that really two technicians should do?

✈️ “No, I don’t need any help; I know what I’m doing!”

# Dirty Dozen – Lack of Teamwork

## ✈️ Safety Nets

- ✈️ Always discuss and plan the Who, What, When, Where, and How of the task to be done
- ✈️ Insure that everyone understands and agrees

# Accident Model

## The Domino Theory



**Dominos**

# Reason's Swiss Cheese Model

**Organizational Factors**

Latent Condition

**Unsafe Supervision**

Latent Condition

**Unsafe Act Preconditions**

Latent Condition

**Unsafe Acts**

Active Failure

**Accident**

**HFACS-**  
*Human Factors Analysis  
& Classification System*

# Human Factors Prevention

- Recap
  - We're all human and we will make mistakes
  - Know your own limits
  - Learn to recognize it in others
- Cure the cause and not the symptom

# My Thanks

- FAA
  - Lou Lerda – Safety Program Manager, Seattle, WA FSDO
  - Atlanta FSDO-11
- Jim Lumley & GWBAA

# Human Factors in Aviation Maintenance



**Questions?**