A practical Human Factors approach to managing error in aviation maintenance

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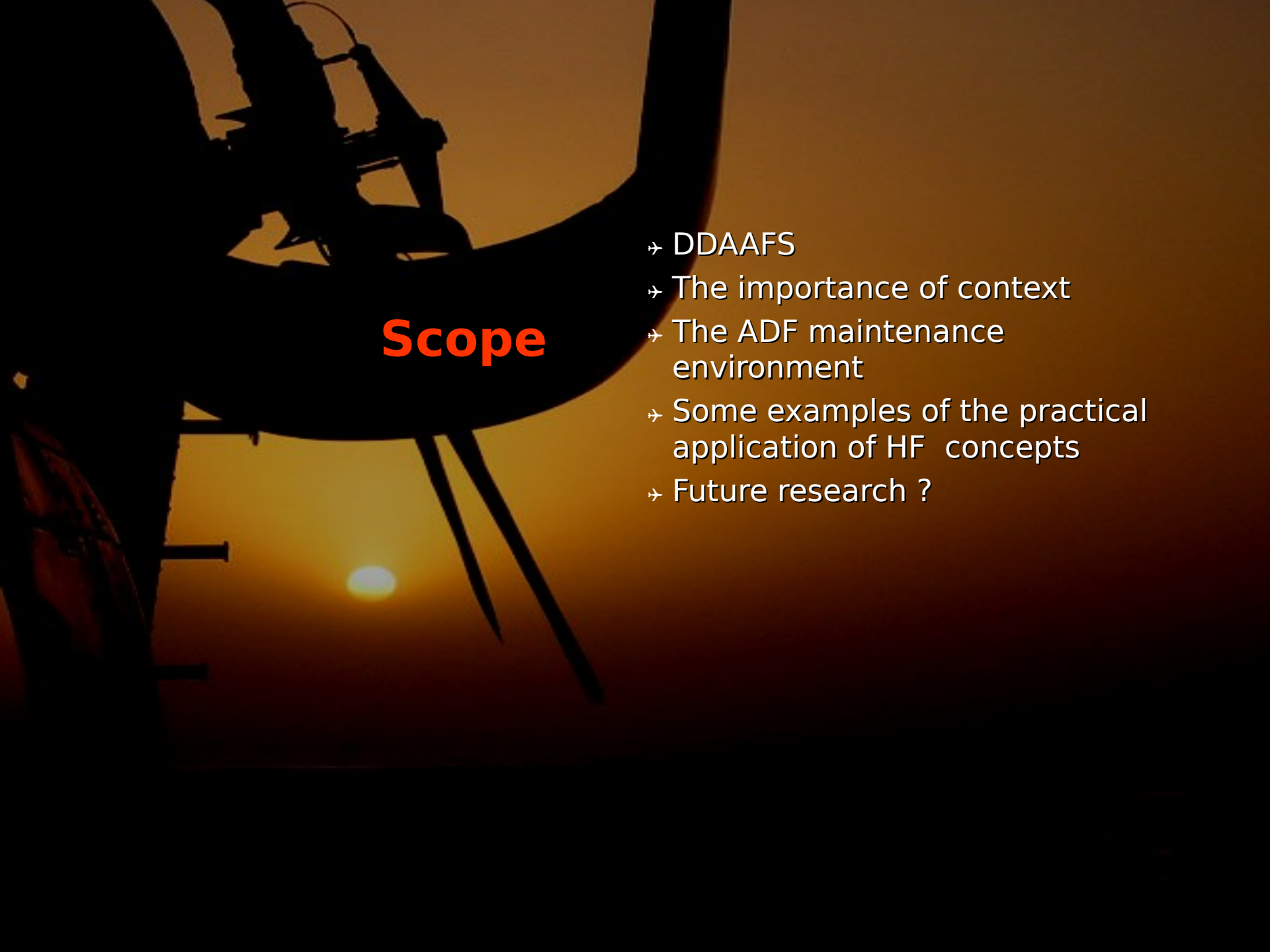


Scope

- DDAAFS
- The importance of context
- The ADF maintenance environment
- Some examples of the practical application of HF concepts
- Future research ?

WHO ARE WE ?

WHAT DO WE DO ?

WHERE ARE WE BASED ?

CONTEXT :
THE ADF AVIATION MAINTENANCE ENVIRONMENT

- The ADF aviation maintenance environment is variable and presents a number of unique Human Factors challenges

NAVY ARMY AIR FORCE

- FIXED - WING
- ROTARY - WING
- UAV
- CIVIL CONTRACTOR

ADF AVIATION MAINTENANCE ENVIRONMENT

ADF AVIATION MAINTENANCE ENVIRONMENT

Deployed Operations

Challenges:

- The environment - heat, dust, visibility, stress
- In field maintenance
- Physical and mental fatigue
- At the end of an extended supply chain
- Difficulties with logistics and spares support

ADF AVIATION MAINTENANCE ENVIRONMENT

Combined and Joint Operations

Challenges:

- Non commonality of equipment
- Different operational standards
- Different levels of training and experience
- Comm’s - Language / Jargon

NAVY | ARMY | AIR FORCE

ADF AVIATION MAINTENANCE ENVIRONMENT

Civil Support - Bushfire/Flood/Search and Rescue

CHALLENGES:

Maintenance environment – Poor Weather, Heat, Visibility, High Winds, Smoke, Ash, Rain, Humidity

Aircraft servicing limits

Interoperation with civilian aircraft and agencies

Deployed maintenance requirements in the field

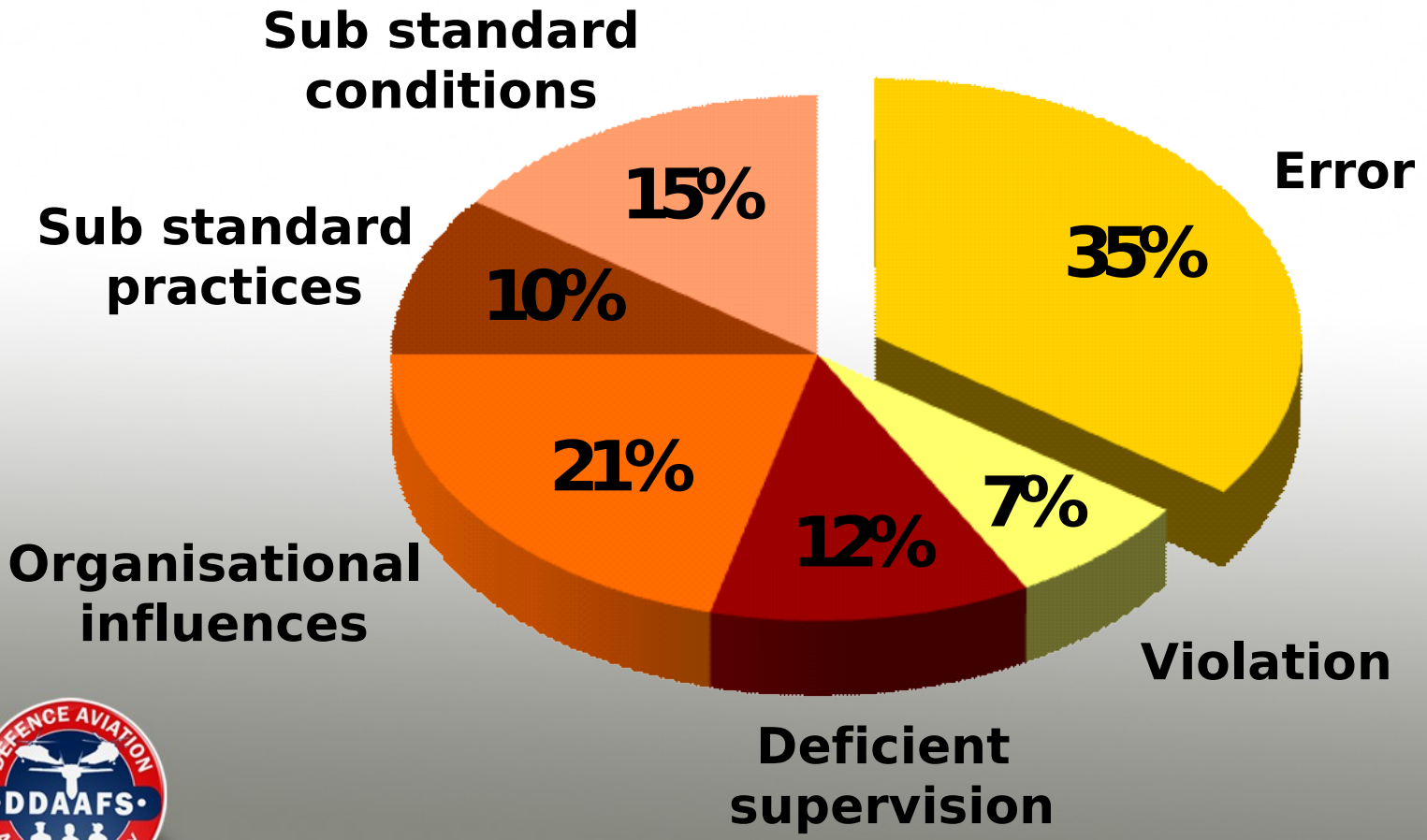
THE OPERATING ENVIRONMENT

The need to address Maintenance Human Factors issues

Maintenance Human Factors have been a significant contributor to a number of ADF accidents and serious incidents…

A/C TYPE	PROBLEM
C130	Main wheel brown-out skid
F18	Fuel line connection failure
SK50	Flight Control disconnect (NIAS)
F111	Main wheel departure
S70A	Fire extinguisher discharge
P3C	Control cable chaffing/failure

What can we learn from our safety reporting data ?



The real HF challenge...

‘The real challenge (for the HF practitioner) is converting the vast amount of (HF) information into understandable, practical (and workable) solutions for your organisation’.

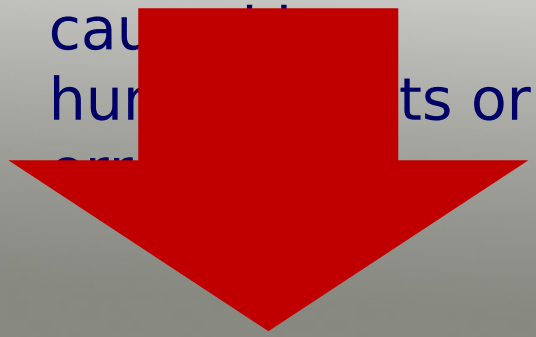
(After - Johnson and Maddox , 2007)

The Human Element

Can we work on the up-side ?

THE DOWNSIDE

Accident statistics show that a high percentage are cau hu ts or



HE UPSIDE

100% of solutions are also the result of Human input.

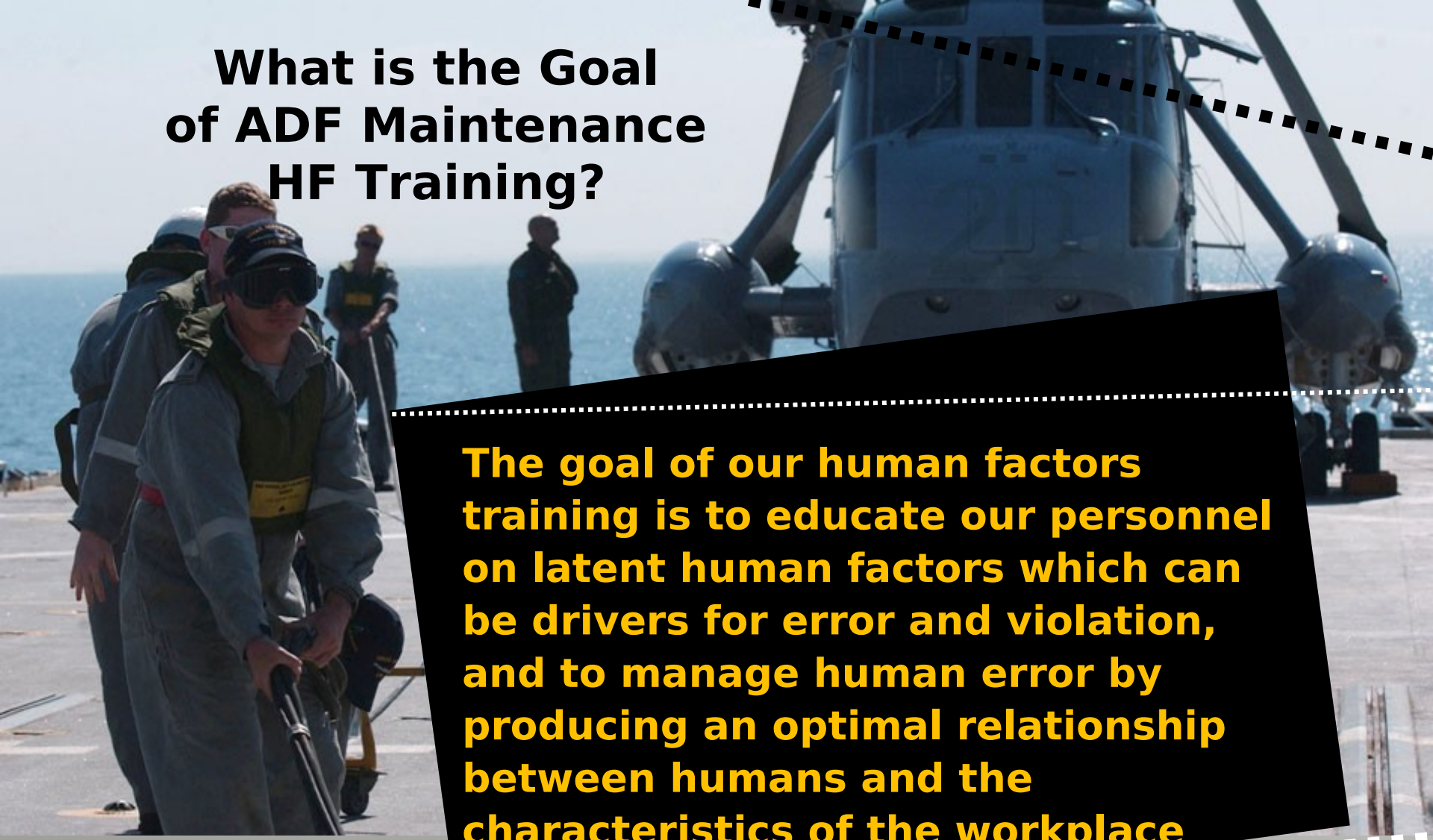
Maintenance HUMAN FACTORS

In response to the HF issues revealed through analysis of our safety reporting data, DDAAFS has developed an interactive MHF program.

DEFENCE AVIATION DDAAFS AIR FORCE SAFETY

NAVY | ARMY | AIR FORCE

What is the Goal of ADF Maintenance HF Training?



The goal of our human factors training is to educate our personnel on latent human factors which can be drivers for error and violation, and to manage human error by producing an optimal relationship between humans and the characteristics of the workplace within which they operate.

Maintenance Human Factors program

- **12 Modules covered:**
  - Introduction
  - Human behaviour
  - Human performance
  - Situational awareness
  - Error and violation
  - Safety culture
  - Environmental factors
  - Communication
  - Teamwork
  - Stress, fatigue and other factors
  - MHF Review
  - Professionalism and safety reporting


Maintenance
HUMAN FACTORS

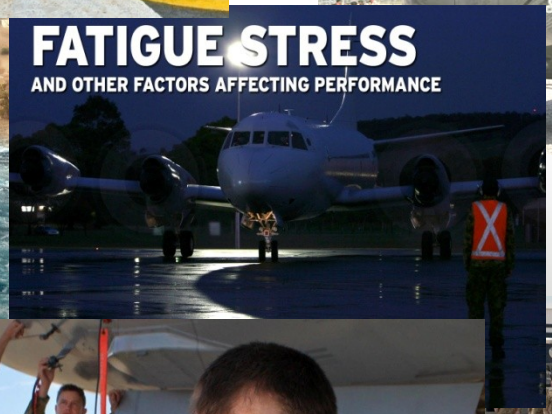

SAFETY
CULTURE


SITUATIONAL
AWARENESS


COMMUNICATION


HUMAN
BEHAVIOUR


Professionalism
and safety reporting


FATIGUE STRESS
AND OTHER FACTORS AFFECTING PERFORMANCE

ENVIRONMENTAL FACTORS


HUMAN
PERFORMANCE
LIMITATIONS


Maintenance
HUMAN FACTORS


TEAMWORK

Maintenance Human Factors program

- **Course is designed for peer to peer delivery in modular stand alone format**
- **For every (HF) issue raised, an appropriate management tool is provided/discussed**
- **The package includes a number of integrated HF tools and processes designed to support cultural change and to manage maintenance error (and violation).**

PRACTICAL INTEGRATED MHF TOOLS

How do we get our personnel to think Human Factors ?

- The MHF course incorporates a modified version of the PEAR model (Johnson and Maddox, 2008) and it identifies four basic areas of consideration:
  - **People**
  - **Environment**
  - **Actions**
  - **Resources**

The ‘PEAR’ notepad

The PEAR notepad is designed for use at all levels and serves as a simple reminder of the Human Factors influences that may need to be considered in the maintenance workplace.

The ‘PEAR’ notepad

Before it goes ‘PEAR shaped’ THINK –

HUMAN FACTORS

PEOPLE

Doing	Thinking	Interacting
• Physical limitations	• Trained	• Supervision
• Sensory limitations	• Knowledge	• Mentoring
• Current	• Experience	• Relationships
• Competent	• Attitude	• Communication
• Authorised	• Confidence	• Leadership
• Briefed	• Motivation	• Followership
• Fatigue	• Fatigue	• Stress

ENVIRONMENT

Physical	Organisational
• Weather	• Management
• Location (in/out)	• Supervision
• Workspace	• Manning levels
• Lighting	• Team make-up
• Noise	• Leadership
• Distractions	• Pressures
• Housekeeping	• Morale
• Hazards	• Organisational culture
• Day/Night shift	• Safety culture

ACTIONS

Actions	
• Get information	• Communication
• Steps/sequence	• Management
• Briefing/authorisation	• Supervision
• Preparation	• Inspection
• Application of knowledge	• Certification
• Application of skill	• Documentation

RESOURCES

Resources		
• Time	• Facilities	• Heating
• Personnel	• Budget	• Cooling
• Tools	• Publications	• Lighting
• Consumables	• Procedures	• PPE
• Training	• DRN/CAMM2	• Spares
• Fixtures	• GSE	• Repairables

People

Doing

- Physical Limitations
- Sensory limitations
- Current
- Competent
- Authorised
- Briefed
- Fatigue

Thinking

- Trained
- Knowledge
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Interacting

- Supervision
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Environment

Physical

- Temperature
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- Location (in/out)
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Organisational

- Management
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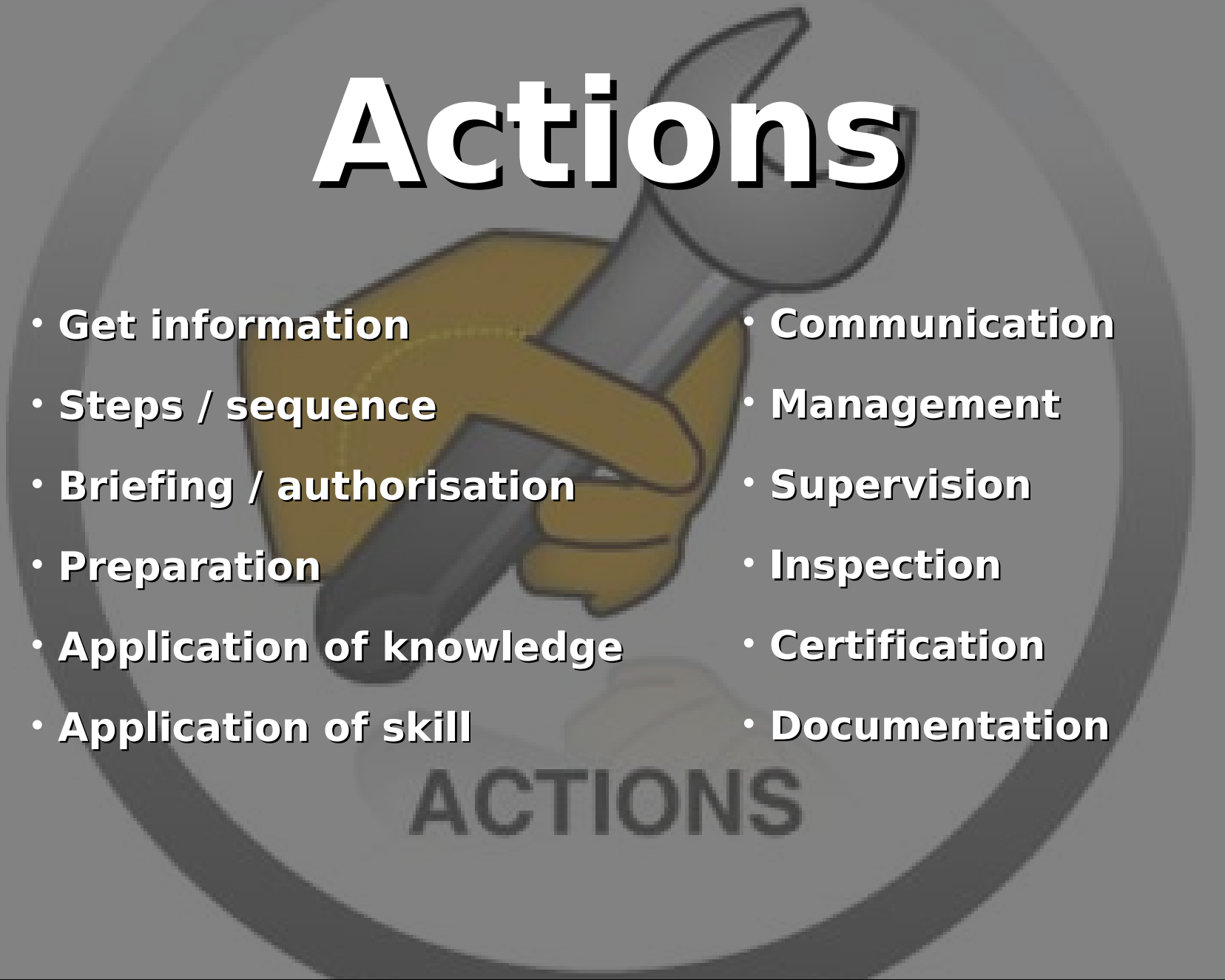
Actions



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- Repairables

Maintenance Pre task checklist

- **Before any maintenance team begins a task, they must ensure they have satisfied all of the pre-requisite conditions needed to minimise the risk of error or deviation from the authorised procedure**

- **The pre-task checklist provides targeted questions relating to the planning of a maintenance task, it ensures that the planning process has reviewed the key human factors that may impact the task**

MAINTENANCE PRE-TASK CHECKLIST

RTE

Are the personnel assigned to the task: competent, authorised (RTE's Checked) and current to carry out it out? Have appropriate levels of supervision been allocated?

FATIGUE

Have fatigue levels been assessed to ensure appropriate allocation of tasks and levels of supervision?

RESPONSIBILITIES

Do the maintenance team understand their roles and responsibilities? The extent of their task? The levels of Certification required? Are the personnel experienced and confident in completing all of the task requirements?

MENTORING

If any members are under mentoring has the impact of their input and actions been considered during task planning (increased completion time etc?)

PEOPLE

WORKLOAD

Has the workload for individual team members been considered? Has each tradesman been allocated a single task at a time?

PRESSURE

Have the organisational pressures (i.e. from op-tempo, serviceability requirements) been discussed with the team?

HAZARDS

Have relevant Aircraft Paperwork, publications and work areas been inspected or reviewed for hazards or restrictions to safely starting or completing the task ?

WORK AREA

Is the task to be carried out in an adequate, safe (i.e. well lit, sheltered, warm / cool) environment with acceptable noise levels?

DISTRACTIONS

Is the workplace and maintenance team free from unnecessary distractions? Is the task on a Safety Critical Item and System? If so has the Safety Critical Maintenance Task environment (including IMI's) been briefed?

TEAM EXPERIENCE

Has the team make-up been reviewed to ensure appropriate levels of task experience within the team?

ENVIRONMENT

AMD

Have all necessary U/S's been entered into the AMD (e.g. panel removal, CTK's in use, power restrictions and references for them)?

HANDOVER

If the task is being handed over, has a comprehensive handover brief been received on all aspects of the outstanding task using a structured handover document?

PROCEDURES/ BRIEFING

Are there current accurate, authorised procedures to complete the task IAW? Has the task procedure, actions and inspection requirements been reviewed and briefed to all members of the maintenance team? Have actions for any unsafe conditions been discussed?

MAINTENANCE MANAGER REVIEW

Has the Maintenance Manager reviewed the maintenance teams' intended course of actions or rectifications for any hazards or risks not identified by the team?

COMMS

Have the communication requirements or difficulties of the task been reviewed? In an emergency can team members be seen and/or heard?

ACTIONS

TIME

Is there sufficient time available to carry out the assigned task before the aircraft is required or the end of shift or a handover period?

PERSONNEL

Have the required number of personnel been allocated to the task IAW the relevant procedure?

SPARES

Are there sufficient major components and break down spares available to meet the potential task needs (e.g. No cannibalisations anticipated)?

PPE

Does the maintenance team have the appropriate PPE required to safely carry out the task? Are they trained to use it?

GSE

Does the maintenance team have all the listed or required serviceable tools, consumables and GSE required to carry out their task? Is there easy CAMM2 access?

RESOURCES

Any **YES** answer is a **GREEN** and acceptable for that element, a **NO** is a **RED** and requires action to address the problem or deficiency at the appropriate level. Any answer that is **MARGINAL** or **ONLY JUST** within limits is an **AMBER** and the element should be reviewed. The more ambers the more fully the task should be reassessed. Three or more ambers equates to a **RED**, again indicating that the task should be re-assessed at a higher level.

ALI - 26 November 2009

Shift/task/watch handover

- **Analysis of incident and accident reports has identified the handover of tasks between teams and/or shifts as a major source of miscommunication and error**

- **The use of a consistent and robust handover process should ensure better communication, decreasing the risk of subsequent error.**

SHIFT/WATCH TASK HANDOVER SHEET

UNIT:	AIRCRAFT/EQUIPMENT NO:	CAMM 2 REFERENCE:
SHIFT/WATCH:	TASK DETAILS:	
TIME/DATE:	MAINTENANCE PROCEDURE REFERENCE:	

STEPS COMPLETED:
STEPS REQUIRED:
POWER RESTRICTIONS/SAFETY HAZARDS:
ITEMS/EQUIPMENT DISCONNECTED OR REMOVED FOR ACCESS:
TEST EQUIPMENT/GSE IN USE:
PEAR ASSESSMENT CARRIED OUT, LIST ANY IDENTIFIED DEFICIENCIES:
ADDITIONAL COMMENTS, INCLUDING FAULT FINDING CARRIED OUT:

NAME/RANK:	TRADE/POSITION:

(DEVELOPED BY HF CELL – DDAAFS)
AL1 - SEPTEMBER 2009

Interruptions and distractions

- **Analysis of ADF incident and accident reports has identified interruptions and distractions during maintenance to be a significant driver for error, particularly errors of omission.**

- **An individual having been distracted or interrupted during a task is usually unaware that an action or step may have been missed or left incomplete.**

Interruptions and distractions

- **The Reality…**

- **INTERRUPTIONS AND DISTRACTIONS ARE COMMON IN THE AVIATION MAINTENANCE ENVIRONMENT**

Interruptions and distractions

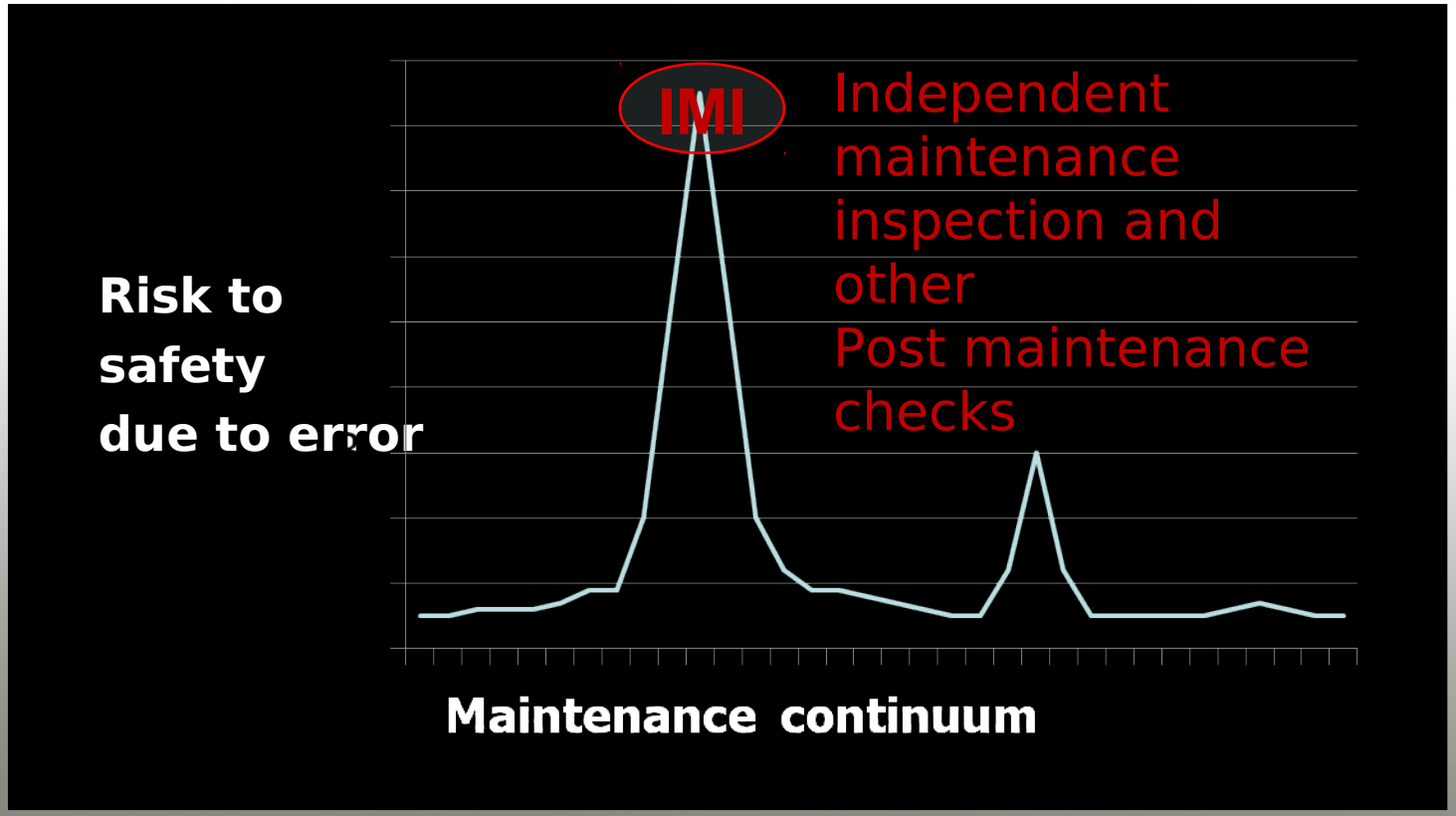
- **MHF technique if staff interrupted:**
  - **Personnel should refer back to maintenance publications**
  - **We train our staff to stop and think – before interrupting someone on a maintenance task (is the interruption necessary?)**

- **IF STAFF ARE INTERUPTED OR DISTRACTED …**
  - **They are briefed to go back three steps or to a logical break in the maintenance task or process and recheck work before continuing.**

The future ?

- **Do we need to re-think the way we conduct aviation maintenance?**
- **Can/should we accept interruptions and distractions during high risk/safety critical maintenance?**
- **Would you interrupt a surgeon carrying out open heart surgery to tell her that her husband is on the phone and wants to know what he should pick up for dinner?**

How do we deal with the risk of error in the maintenance continuum ?



How do we deal with the risk of error in the maintenance continuum ?

An independent maintenance inspection (although a good error trap) is equivalent to trying to catch the horse after it has bolted

But could/should we try to prevent the horse from bolting in the first place ?

A proposal…
the ‘focused maintenance environment’

An environment where attention and communication is focused on the safe and accurate completion of the specific maintenance task. No unnecessary discussion or distraction should occur.

Interruptions from internal or external sources should only occur if they relate to the task at hand or if there are safety implications.

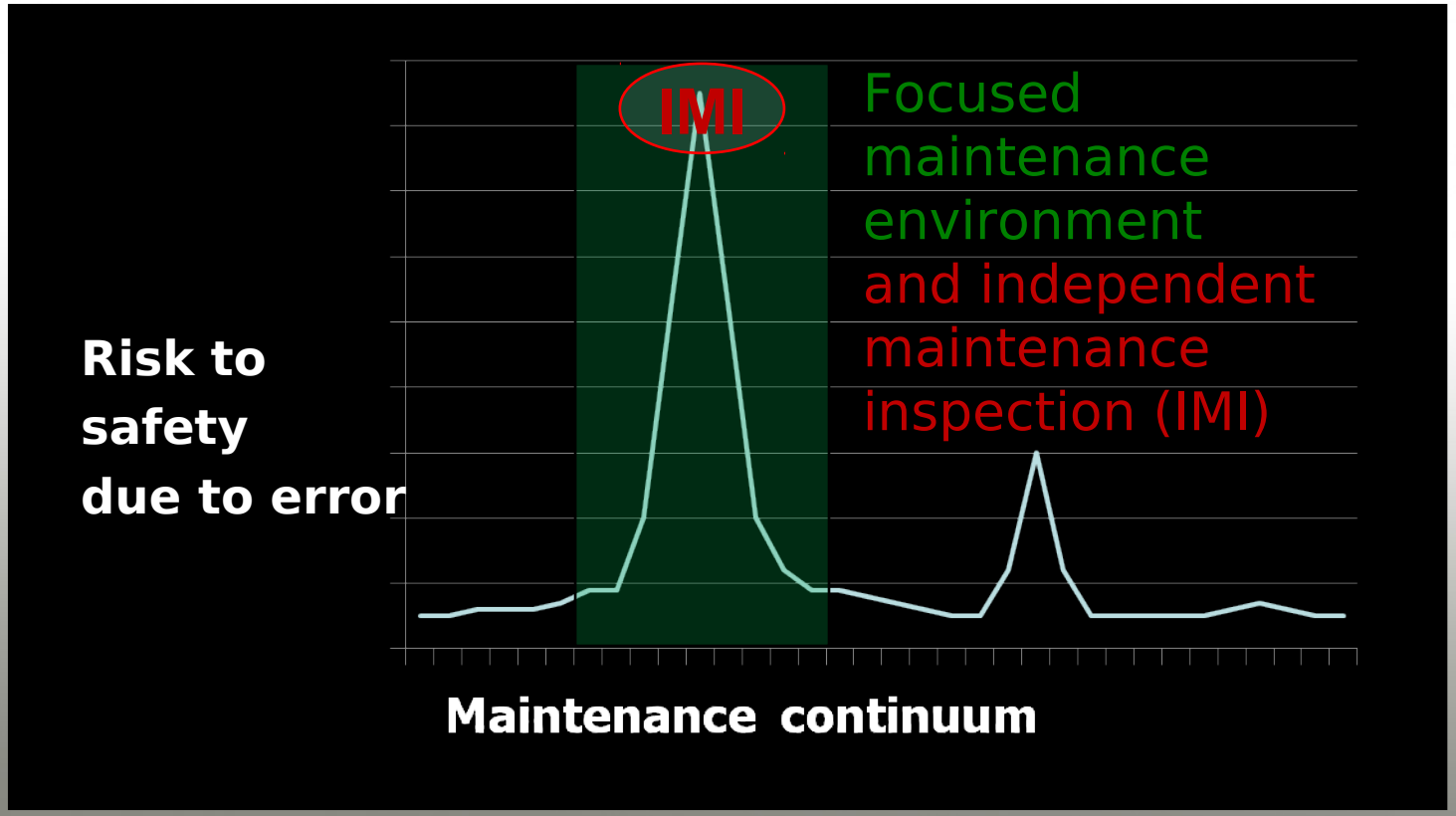
When would the ‘focused maintenance environment’ be used ?

- **The focused maintenance environment could be utilised for those tasks identified by the maintenance manager/supervisor (or OEM) as having a low error tolerance for safety (or having a high risk to safety due to error)**
  - **An example might be the reconnection of a non redundant primary flight control**

How would external personnel know that a ‘focused maintenance environment’ is in place ?

- **A simple identifier such as signs/arm bands/Hi-visibility vests etc, could be used to identify personnel in the ‘focused maintenance environment’ to external maintenance and other personnel.**

The ‘focused maintenance environment’



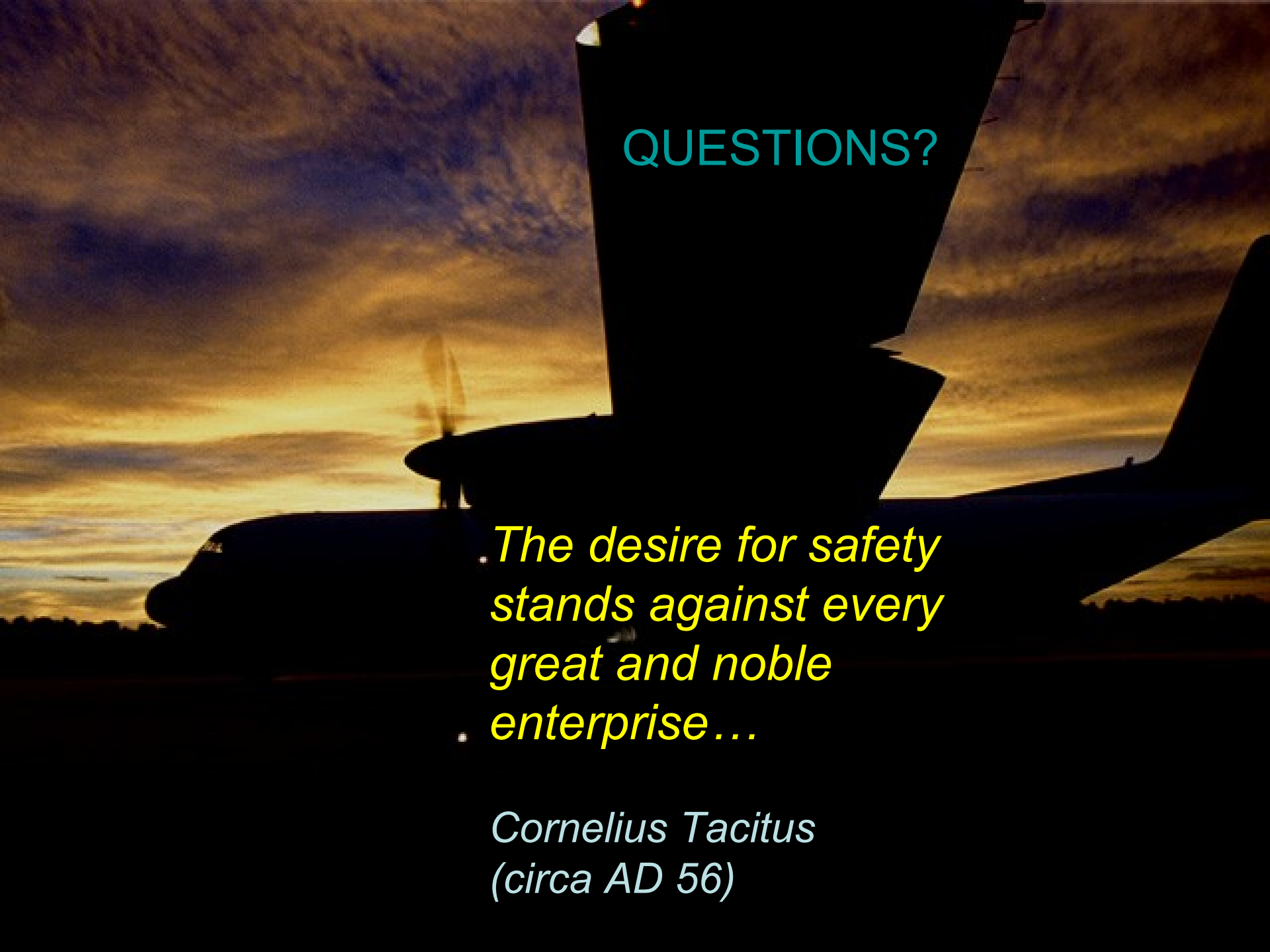
Does the ‘focused maintenance environment’ imply that other maintenance is not important ?

- **NO**

- **The aim of the focused maintenance environment would be to reinforce the concept of airworthiness and to recognise that some areas of maintenance have a higher level of criticality to safety than others**

Conclusion

- Practical HF tools do not have to be complex
- It is sometimes worth reviewing how we do business holistically -
  - if you had a blank canvas is that how we would do it today?
- More research is needed in the area of error drivers within aviation maintenance
- Are concepts such as the ‘focused maintenance environment’ worthy of further consideration, discussion or research?


QUESTIONS?
The desire for safety stands against every great and noble enterprise…
Cornelius Tacitus
(circa AD 56)