JAA
Joint Aviation Authorities

Human Factors in Maintenance Working Group Report

JAA Maintenance Human Factors Working Group
8 May 2001

Intentionally Left Blank

Human Factors in Maintenance
Working Group Report

Content:

Intentionally Left Blank

Human Factors in Maintenance
Working Group Report

1. General

1.1 Introduction & Terms of Reference

According to recent publications, reports, etc, on aviation safety, between 70 and 80 per cent of aircraft accidents are due to human factors. In a significant part of them, a maintenance error is one of the main causes or at least a contributing factor. Furthermore, recent statistics show a relative of increase of accidents where Maintenance is a primary factor. Many of these accidents could have been avoided if basic human factors concepts had been observed

Although accidents have reduced over the years to about 1 per 5 million departures in Western Europe, it has remained at this level with no signs of declining.

With the foreseeable increase of air traffic in the coming years, the number of fatal accidents per year will undoubtedly increase, giving the public the wrong impression that the skies are becoming less safe.

In order to stabilise the number of fatal accidents per year, the main aviation safety authorities around the world (FAA, Transport Canada, JAA) have undertaken a series of initiatives, including the taking into consideration of Human Factors in Operations, Certification and Maintenance.

As far as Maintenance is concerned, while the FAA has decided to focus on research, publication of guidance material and the promotion of Human Factors Programmes without changing the regulatory framework, the JAA and Transport Canada decided to enhance their maintenance regulations by imbedding human factors concepts in them.

Accordingly the JAA Committee decided, in December 1998, to set up a JAA Maintenance Human Factors Working Group with the view of improving the JAR 145 requirements in the light of recent developments in Maintenance Human Factors research. In order to ensure a consistent approach with Human Factors development in Certification and Operation, the Maintenance Human Factors Working Group had to work in close co-operation with the JAA Human Factors Steering Group

1.2 Working Group Members

The Working Group included a balanced membership of “Authority” representatives (5) and “Industry” representatives (5). It had its first meeting in January 1999.

The working Group member ship as of 1 January 2001 was:

J.M Cluzeau	*Central JAA*
E. Demosthenous	*Aircraft Engineer International (AEI)*
D. Hall	*CAA-UK*
J. Kerkhoff	*EAIA/Transavia.*
F. Merritt	*CAA-UK*
D. Adriaenssens	*ERA / Delta Air Transport*
K. Zwart	*Nationale Luchtvaart Autoriteit (NLA) Netherlands.*
M. Costantini	*ENAC Italy / Central JAA*
T. Foltis	*AEA / LHT*
G. Galéa	*AEA / Air France*

1.3 Working method

The agreed working method was the following:

At a first stage, the working group would review and analyse information, data, incident/accidents reports, publications, research material, etc… in order to identify Maintenance Human Factors Issues and classify them by order of importance. It was decided to give a level of criticality (from 1 to 3) to each human factor topic, 1 being the more critical level.

The working Group would then work on the more critical issues, being understood that less critical issues could be incorporated in the rule at a later stage. The prevailing idea was to avoid overweighing the Notice of Proposed Amendment (NPA) on Human Factors with too many issues, the risk being that the NPA process could be delayed by too many comments on secondary issues.

The working group was then required to establish a detailed work plan, to show which issue would be addressed and how it should be addressed (by a JAR change, and AMC/IEM or guidance material). It should be noted that only level 1 (critical) organisational issues were included in the work plan, but all level 1, 2 and 3 training issues were included, as it was agreed that training on maintenance human factors should be comprehensive and include all, minor and major issues. However, while "shortage of engineers" was identified as a level 1 organisational issue, it was not included in the work plan, because the working group considered that solving this particular issue was beyond the capability of the regulator.

At a second stage the working group had to draft an NPA based upon the detailed work programme.

The recent ICAO Annex 6 changes on Maintenance Human Factors were also taken into consideration. The Working Group considered its draft proposal is in compliance with ICAO Annex 6 paragraph 8.7.5.4 on Human Factors training. However the Working Group did not identify any issue directly related to Maintenance Programmes, therefore its proposal intentionally does not address ICAO Annex 6 paragraph 8.3 on Maintenance Programmes.

The drafting phase has been completed on January 2001, then submitted to the Maintenance Sectorial Team, who discussed it during their March 2001 meeting.

2. Human Factors issues

2.1 Definitions

The working group identified two categories of issues: those that can be addressed through an organisation rule change ("organisational issues") and those that can be addressed through a dedicated Human Factors training ("training issues"). Obviously some issues belong to both groups

For instance the performance of "Duplicate Inspections" is typically an organisational issue, while the "Limitation of Human Performance" is a training issue, but the development of a good "Safety Culture" pertains to both groups.

2.2 List and priorities

Attachment 1 to this report includes the list of prioritised Maintenance Human Factors Issues. For every Human Factors issue, it specifies the justification for its criticality and what action is recommended. This table is subdivided in two parts:

- Part 1 includes Human Factors issues to be addressed through a dedicated training programme for maintenance personnel ("training issues").
- Part 2 includes Human factors issues for which it is envisaged to change / improve a JAA rule ("organisational issues"). Obviously some Human Factors issues belong to both parts.

2.3 Justifications

Attachment 2 to this report includes expanded justification for the criticality of the Human Factors issue. In particular, it refers to known incidents and accidents.

3. Details on Human Factors Issues

The Working Group scope of work was not limited to JAR 145; it also included in principle JAR-OPS Subpart M, JAR 66 and JAR 147. The detailed review of Maintenance Human Factors issues did not indicate that any change was needed for these regulations. In fact, all the proposed changes concentrate on JAR 145: this is not the result of a postulate but is an outcome of the analysis explained above. JAR 66 contains a requirement for certifying staff to demonstrate a basic knowledge level in Human Factors by examination (ref. JAR 66 Appendix 1 Module 9). Paragraph 3.2.4 of this report will explain how this interact with the Working Group's proposal to require Human Factors training

As mentioned above, the Working Group identified 2 categories of changes to JAR 145:

- Changes affecting the JAR 145 approved maintenance organisation itself – qualified as "organisational issues"-, such as a new paragraph on "maintenance planning" and an improved paragraph on "maintenance data".
- Changes affecting maintenance personnel, more specifically the introduction of a Human Factors training requirement –qualified as "training issues".

More specifically, the Working Group proposes to address the following Human Factors Issues:

3.1 Organisational issues:

3.1.1 Design / Maintenance Interface

Inaccuracies, ambiguities, etc in maintenance data may lead to maintenance errors. Indirectly, they may also encourage or give good reasons to maintenance personnel to deviate from these instructions.

The Working Group proposes that a new JAR and AMC require that inaccurate, ambiguous, incomplete maintenance procedures practices, information or maintenance instructions contained in the maintenance data used by personnel be notified to the TC holder.

It is acknowledged that the standard itself of TC holder's instructions is not a maintenance regulatory issue, but a certification regulatory issue, therefore JAR 145 cannot address this. However the Working Group has ensured that the JAA Human Factors Steering Group is considering this issue with Certification.

3.1.2 Safety culture

While it is recognised that it is impractical to write a requirement demanding a safety culture, one can write requirements and guidance material that set out the *elements* that would enable one to flourish.

The Working Group proposes that a new JAR 145 paragraph require the maintenance organisation respectively to establish and publish the organisation's safety policy. This paragraph would identify the accountable manager as the person responsible for establishing and promoting this safety policy, and Section 2 of JAR 145 would further expand on the content of a safety policy

3.1.3 Internal Occurrence Reporting

Another key element for the development of a safety culture is a "Internal Occurrence Reporting System" which consists of a closed loop occurrence & safety hazard reporting, recording & investigation system. A similar system has been proposed through NPA 145-10. The JAA Maintenance Human Factors working group considered minor changes were needed to make the NPA 145-10 proposal an acceptable basis for an Internal Occurrence Reporting System. Comments on NPA 145-10 were submitted to the Maintenance Division on behalf of the working group.

Furthermore the Working Group considers that in order to ensure that effective Occurrence Reporting Systems will be put in place, additional guidance would be needed by the Industry.

The Working Group has prepared more detailed information on the subject. This information is included in this report as Attachment 3.

3.1.4 Procedural Non-compliance

Failure to comply with good maintenance procedures can hardly be covered by regulation. It is a matter of education, safety culture and discipline. However, failure to comply with poor procedures, can be minimised by focusing the requirement on a system that ensures procedures are accurate, appropriate and reflect best practice

The Working Group proposes that JAR 145 be amended to require that human factors principles be taken into account when establishing and writing procedures, and that new AMC material recommend, among other things, the involvement of the end users in writing the procedures, the verification and validation of the procedures, and an effective mechanism for reporting errors and ambiguities and changing / updating the procedures.

The Working Group has prepared more detailed information on the subject. This information is included as Attachment 4 to this report.

3.1.5 Shift and task handover

This is a routine process that repeatedly appears in accident and incident reports.

The Working Group recommends that a new JAR 145 paragraph specifically require a shift and task handover procedure acceptable to the NAA and that additional AMC material provide material that would describe best practice based on current knowledge and scientific research.

3.1.6 Fatigue of personnel

The effect of fatigue on maintenance errors is a well established fact.

The Working Group proposes that a new JAR 145 paragraph require the organisation's production planning procedures to take into account the limitations of human performance, focusing on the fatigue aspect.

The Working Group believes that taking into account the impact of fatigue in production planning is not an issue that can be regulated in a prescriptive manner. Consideration should be given to allowing each JAR 145 approved maintenance organisation to find creative solutions adapted to their own organisational structure. More detailed information has also been prepared on this issue. This information is included as Attachment 5 to this report.

Finally the Working Group understands that the JAA will not be addressing fatigue through duty time limitations, as this is considered as a social issue, not to be covered by a JAA rule. The EU working time directive will cover this in the longer term.

3.1.7 Error capturing

Error capturing forms an important element of the safety net in the approved maintenance organisation. Duplicate inspections may be a means of capturing maintenance errors, but not necessarily the only means.

The Working Group proposes that new AMC material recommend that duplicate inspections be considered as a possible means of error capturing. The AMC should provide additional guidance as to the circumstances where this might be warranted.

3.1.8 Preparation of work (tasks, equipment and spares)

Current JAR 145 does not require a procedure on planning of work. However, the absence of effective planning/preparation may contribute towards increased work pressure, which itself may lead to deviation from procedures. Deviation from procedures is known as a contributing factor in many aircraft incidents and accidents.

The Working Group proposes that new JAR and AMC material clarify the objective of good planning/preparation and include further guidance on elements to consider when establishing the planning/preparation procedure.

3.1.9 Responsibility for "Signing off" tasks.

Recent research proved that many maintenance tasks are signed off while not seen or checked by authorised personnel, potentially leading to incomplete maintenance.

The Working Group proposes that new AMC material elaborate on the meaning of sign-off and the need to self-check or inspect the task before signing off.

3.2 Training issues

3.2.1 General

The Working Group considers that the development of human factors related skills, knowledge and attitudes in the maintenance organisation should be achieved through the training of all concerned maintenance personnel on the subject.

The Working Group proposes to add new JAR and AMC paragraphs on Human factors training. These paragraphs would identify the maintenance staff concerned and would address the need for both initial and continuation training.

3.2.2 Personnel to be trained

The Working Group proposes that all personnel whose error or poor decision could affect safety or compliance with JAR 145. More specifically, the Working Group identified personnel in the following functions:

-Post-holders, managers, supervisors
-Certifying staff, technicians, and mechanics
-Planners, engineers,
-Quality control/assurance staff
-Specialised services staff
-Human factors staff/ Human factors trainers
-Store department staff, Purchasing dept. staff
-Ground equipment operators
-Contract staff in the above categories

3.2.3 Initial training

The Working Group developed a syllabus on Maintenance Human Factors training to be included in an Appendix to JAR 145

Contrarily to JAR 66 Appendix 1, this syllabus does not include knowledge level requirements (see Attachment 6). The intent is at a first stage to give the maintenance organisation the flexibility to adapt the training syllabus to the size and work scope of the organisation.

The Working Group also developed more detailed information on Human Factors training. The intent of this material is to provide additional support to those organisations that will develop training courses. This guidance material identifies training objectives in term of skill, knowledge and attitude, and includes examples and references on subjects to be taught. This draft guidance material is included in Attachment 7.

3.2.4 Continuation training

The Working Group considers that the implementation of Maintenance Human Factors principles in an organisation can only be successful if concerned personnel are regularly fed back and retrained on the issue. The experience shows that an initial human factor training without continuation training proves inefficient after a few years. The Working Group therefore proposes that

continuation training on Human Factors be performed every 2 years and include a feedback element on Human Factors issues identified in the organisation.

3.2.5 Training Syllabus of JAR 66 Module 9

JAR 66 already includes a requirement to demonstrate knowledge of Human Factors elements, which included in Module 9 of the syllabus. This applies to certifying staff only and is not a requirement for training: it is only tested by means of examination.

However the Working Group's experience is that an appreciation of human factors can only be obtained by training, ideally within the context of the organisation within which the people work. Furthermore an examination only cannot really assess certain aspects such like "skill" and above all "attitude", which are 2 training objectives identified in the draft guidance material (see attachment 7): training is the way forward.

The Working Group understands that it is not the intention of either JAR 66 or JAR 145 to have unnecessary overlap in terms of human factors training, therefore it explored various possibilities to ensure the consistency between JAR 145 Human Factors training and JAR 66 Human Factors examination.

In the information material (see attachment 7), the Working Group proposes the solution of cross credits –under specific conditions- between JAR 145 training and JAR 66 examination on Human Factors.

Another possibility would be, if the Working Group proposed rule changes are adopted, to take Human Factors out of JAR 66, because the Working Group proposal would in practice supersede the JAR 66 requirement (the WG proposal includes all functions of maintenance personnel and is deemed to address the issue at a higher level)

4. Conclusion

Based upon the above recommendations, the JAA Maintenance Human Factors Working Group submitted a draft proposal for a JAR 145 NPA (Notice of Propose Amendment) to the JAA Maintenance Director. The Working Group expects that this report will help understanding its approach toward Maintenance Human Factors and will provide good support information for the discussions within the JAA Maintenance Sectorial Team and during the NPA public comment period, as well as in the application of good human factors principles when the NPA is adopted.

Jean-Marc Cluzeau
Chairman, JAA Maintenance Human Factors Working Group

Intentionally Left Blank

Attachment 1

JAA Maintenance Human Factors Working Group

List of proposed improvements to JAA Maintenance regulations

Intentionally Left Blank

Human Factors in Maintenance
Working Group Report

Maintenance Human Factors Issues

Note : Maintenance Human Factors Issues are sorted by criticality, “1” being the more critical and “3” the less critical

Part 1 Training issues

	Issue	Critic-ality	Justification	Action
1	Behaviour -error provoking -non compliance with procedures / violations	1	A lot of maintenance errors and unsafe conditions are due to behavioural aspects According to the Adams research (draft report), 1/3 of maintenance tasks are not performed i.a.w. the maintenance manual Maintenance personnel non complying with procedures is reported as contributing factor in many accidents/incidents	HF training should address: the behavioural aspect the causes and effect of not complying with procedures communication the causes and effect of fatigue recurrent Human Factors Training the interest of error reporting system & non punitive culture the effect of interruptions the effects of poor planning design of maintenance documentation the causes and effect of excessive pressure the awareness that (temporary) unfitness must be considered when performing maintenance tasks the awareness that repetitive tasks may increase chance of errors due to upcoming complacency the awareness that problems may arise from different cultures Identify categories of personnel concerned by HF training and develop related training syllabus. Duration, frequency, objectives of each training should be defined Requirements for instructors should be specified.
2	Communication	1	Poor communication has been reported as a contributing factor in many incidents/accidents	
3	Fatigue	1	• Long hours worked increases vulnerability to error. • Several maintenance incidents had a contributing factor fatigue due to excessive hours of work (refer to reports by CHIRP in ‘Feedback’ issues 46, 47, 50)	
4	Human Factors Training	1	Although several organisations have introduced HF training, it seems that sometimes it is not very successful. Its success depends on several factors.	
5	Safety culture	1	To reduce maintenance errors is essential to determine why errors occur and what can be done to improve the reliability of the maintenance system. This is the aim of an Error reporting and analysis system	

	Issue	Critic-ality	Justification	Action
6.	Interruptions whilst performing tasks	1	AAIB reports cite interruptions as a contributing factor in three near fatal accidents	
7.	Poor planning of tasks, equipment and spares	1	Many reports show that poor planning lead to deviations from procedures and was a contributing factor to incidents	
8.	Technical documen-tation : • access • quality	2	The quality of and access to the (many) documents used in maintenance organisation (Work cards, Maintenance Manual, etc.) has a direct impact on maintenance errors	
9.	Pressure	2	Excessive pressure does lead to maintenance errors	
10.	Personal performance: • eyesight • hearing • physical condition	3	can lead to incomplete work and / or poor quality due to lack of personal perception /awareness	
11.	Repetitive tasks (complacency)	3	repetitive tasks may lead to complacency / distraction and thus cause errors	
12.	culture issues	3	intercultural problems may lead to lack of communication between personnel of different origin	

Part 2 Organisational Issues

	Issue	Critic-ality	Justification	Action
1.	Design : • manufacturer's documentation • maintainability • no Maintenance Manual validation	1	• Manuals not followed or difficult to follow because of poor quality • Cross connections and other design deficiencies have been major contributing factors in past accidents and incidents • Note: B777 did have its manuals validated and over 1000 changes were needed	Maintenance organisations should ensure that design issues are relayed to the manufacturers, in the hope that they will feed back into the design of new aircraft / components/documentation etc.. Side action : co-ordinate with Human Factors Steering Group actions for design/certification
2	Fatigue	1	• Long hours worked increases vulnerability to error. • Several maintenance incidents had a contributing factor fatigue due to excessive hours of work (refer to reports by CHIRP in 'Feedback' issues 46, 47, 50	-Adequate staffing number and qualification. -Take into consideration circadian rhythms when designing and planning work. (pending availability of additional studies and organisational models) -Consideration be given to duty time limitation (pending JAA MC action)
3	Safety culture	1	To reduce maintenance errors is essential to determine why errors occur and what can be done to improve the reliability of the maintenance system. This is the aim of an Error reporting and analysis system	Develop guidance material for Error reporting/analysis system. The regulation should address the need for a Human error reporting/analysis system. AMC material should spell out the elements of such a system and promote the interest of non punitive culture.
4	Inspection	1	History has shown double inspection helps capture maintenance errors	Develop a requirement for double inspection. Identify items subjected to double inspection
5	Non compliance with procedures	1	Maintenance personnel non complying with procedures is reported as contributing factor in many accidents/incidents	Develop guidance on how to develop "good" procedures. Such guidance should address the validation of procedures and the necessary user's feed back
6	Poor planning of tasks, equipment and spares	1	Many reports show that poor planning lead to deviations from procedures and was a contributing factor to incidents	AMC material to cover pre-task planning.
7.	Shift / Task handover (note the training	1	Shift/task handover is known as an important issue as it could lead to incomplete maintenance if not properly	The regulation should address the need for shift/task handover procedures. AMC material should spell out the preferred elements of

	Issue	Critic-ality	Justification	Action
	aspect is covered under "communication")		performed. Criticality is 1 because bad shift handover is known to have been a major contributing factor in an aircraft accident	a shift/task handover procedure.
8	Signing off tasks not seen/ checked	1	Incidents	Procedures to only sign off tasks which has been witnessed or checked.
9	Shortage of engineers	1	UK Royal Aeronautical Society paper; "The challenge for the future", highlights the problem of current and future shortage of aircraft maintenance engineering staff, stating that there exists: "a significant shortage of appropriately skilled labour due to a contraction of the supply of skilled personnel from the armed services, manufacturing sectors, and the traditional airline apprenticeship schemes". The UK Government Transport Sub-Committee of the Environment, Transport and Regional Affairs Committee (ETRAC), have stated: "we are extremely concerned about the shortage of maintenance engineers, both in the Commercial and general Aviation sectors". In 1998, the President of Embrey Riddell University, in the USA, stated: "The worldwide shortage of skilled and trained aviation maintenance technicians has reached a critical stage. Predictions indicated that this	None

	Issue	Critic-ality	Justification	Action
			shortage will continue to worsen as the active fleet is growing while the number of individuals preparing for an aviation maintenance career declines"	
10	Technical documen-tation : • access • quality	2	The quality of and access to the (many) documents used in maintenance organisation (Work cards, Maintenance Manual, etc.) has a direct impact on maintenance errors	Develop general guidance for the design of good (from a HF perspective) documents; ensure proper access to documentation
11	Pressure	2	Excessive pressure does lead to maintenance errors	• Note : The Working Group members' opinion diverge on the possibility to address this issue through an organisational requirement
12	tools & equipment : • design • accessibility • availability	2	poor design, accessibility and availability of tools and equipment may lead to poor work performance because personnel must fight adverse situation rather than concentrate on job performance	• Develop guidance material on validation of internal tooling, accessibility and availability of tools and equipment. • Report to TC Holder tooling that does not work properly • Emphasise tools & equipment monitoring by quality system
13	Workplace : • lighting • temperature / climate • noise	2	Inadequate working conditions may lead to poor work performance because personnel must fight adverse working condition rather than concentrate on job performance.	• Develop guidance material on how working conditions should be designed • Emphasise working conditions monitoring by quality system.
14	Computerisation	3	introduction of a computerised system which was not 'ready' - leading to problems	• Properly test and evaluate computerised systems before going live • Provide training for use

Intentionally Left Blank

Attachment 2

JAA Maintenance Human Factors Working Group

Justifications for proposed improvements to JAA Maintenance regulations

Intentionally Left Blank

Maintenance Human Factors Issues

Part 1 Training issues and their justification

Issue	Justification
Behaviour -error provoking -non compliance with procedures / violations	• A lot of maintenance errors and unsafe conditions are due to behavioural aspects • According to the Adams research (draft report), 1/3 of maintenance tasks are not performed i.a.w. the maintenance manual • Maintenance personnel non complying with procedures is reported as contributing factor in many accidents/incidents • *BAC1-11 windscreen accident - inadequate care, poor trade practices, etc.* • *A320 - failure to comply with procedures; deviations from MM* • *B737-400 incident - short-term and long-term deviations from procedures* • *B737-400 - inadequate reference to MM, and failure to comply with MM in order to save time* • *A320 incident AAIB report stated "the engineers who carried out the flap change demonstrated a willingness to work around difficulties without reference to the design authority, including situations where compliance with the MM could not be achieved".* • *Many incidents from the Netherlands citing human performance/ errors (but not enough detail as to causes)*
Communication	• Poor communication has been reported as a contributing factor in many incidents/accidents • *B737-400 oil pressure loss incident - the line engineer had intended to complete the task himself therefore did not make a written statement or annotation on a work sheet to show where he had got to in the inspection, and the verbal handover was not adequate* • *A320 incident - handovers were verbal only, and ineffective* • *Incidents from Germany, eg. failure to communicate that a system has been de-activated/ re-activated; incidents where engineers have been asked to clear the area for functional checks (eg. landing gear operation) but have not heard, and equipment remains in the way; inadequate detail in ground finding sheets (eg. concerning the precise location of corrosion); etc.* • *Several Dutch incidents, eg. 3289,*

Issue	Justification
Fatigue	• Long hours worked increases vulnerability to error. • Several maintenance incidents had a contributing factor fatigue due to excessive hours of work • *Engineer fatigue was included as a problem in the UK Transport Select Committee Enquiry, 1998.* • *CHIRP reports in 'Feedback' issues 47 p11, 48 p4, 49 p10, 50 p15.* • *B737-400 loss of oil pressure incident. The AAIB report stated that the task "occurred around the time that the Night Base Maintenance Controller's capabilities were likely to be at their lowest".* • *In the BAC1-11 windscreen loss incident, the AAIB report stated that "errors were made more likely by the sleep deprivation and circadian effects associated with the end of a first night shift"* • *In the A320 incident, the AAIB report stated that "the shift handovers took place, for the nightshift engineer, at a time when he could be expected to be tired and with circadian rhythms desynchronised"* • *Flight Safety Foundation paper "managing sleep for night shifts requires personal strategies", March 1999* • *Paper by Alan Simmons, AAIB, stating that when circadian lows are combined with time on shift >8 hours, "research shows the ability of individuals to perform simple cognitive tasks correctly …drops from 10/10 to 1/10"* • *The UK CAA AWN47 states "Tiredness and fatigue can adversely affect performance. Excessive hours of duty and shift working, particularly with multiple shift periods or additional overtime, can lead to problems. …Individuals should be fully aware of the dangers of impaired performance due to these factors and of their personal responsibilities."* • *Valujet accident.* • *There is an Australian study looking into the problem of fatigue in aircraft maintenance engineers - (further details not yet available)* • *FAA research*
Ineffective Human Factors Training	• Although several organisations have introduced HF training, it seems that sometimes it is not very successful. Its success depends on several factors.

Issue	Justification
Safety culture *- no just culture* *- inadequate incident reporting or analysis* *- inadequate maintenance error management* *- lack of support from senior management* *- failing to learn from previous instances*	• To reduce maintenance errors is essential to determine why errors occur and what can be done to improve the reliability of the maintenance system. This is the aim of an Error reporting and analysis system • *All the major experts on human factors and maintenance engineering (Jim Reason, David Marx, etc.) stress the need for a good safety culture as a prerequisite to addressing many of the HF problems* • *Statement from IATA Director "non-punitive reporting o air incidents is an essential element of our safety improvement programme*" • *B737-400 incident - 5 previous similar occurrences before anything was done, and 3 more (+ this one) since then, suggesting that the remedial action was ineffective* • *A320 incident - at least 3 other occurrences where spoilers had been left in maintenance mode - lessons not learned* • *A MEDA investigation carried out by a UK operator showed that an incident where an idle stop plate had been incorrectly installed (resulting in inability to select either thrust reverser on landing), had important contributory factors (MM poorly designed). These would probably not otherwise have been identified and rectified, without a MEDA investigation* • *A320 incident AAIB report "the errors made were a result of a belief on the part of the engineers that the practices employed were justified" - poor safety culture; cutting corners appeared to be condoned by the company*
Interruptions whilst performing tasks	• AAIB reports cite interruptions as a contributing factor in three near fatal accidents • *B737-400 - many interruptions. The AAIB report stated that the borescope inspection task "was clearly of the type which would benefit from being done in isolation and without interruptions"*
Poor planning of tasks, equipment, spares *and resources*	• Many reports show that poor planning lead to deviations from procedures and was a contributing factor to incidents • *A320 - planning was not particularly thorough* • *B737-400 - Minimal pre-planned paperwork* • *B737-400 oil pressure loss incident - frequent staff shortages, including absence of 4 out of 5 supervisors that night. AAIB report stated "If the airline had had an effective system in place to monitor functionally related available manpower vs workload, a shortfall of Line Maintenance engineers and Base Maintenance supervision on the night would have been predicted* • *Examples from Germany, eg: putting out a D-check job caard set for an IL-layover; non-provisioning of a standard parts set for a layover; wrong paint; shipping parts to wrong overhaul agency, etc*
Technical documen-tation : access quality	• The quality of and access to the (many) documents used in maintenance organisation (Work cards, Maintenance Manual, etc.) has a direct impact on maintenance errors

Issue	Justification
Pressure *- actual* *-perceived*	• Excessive pressure could lead to maintenance errors • *BAC1-11 - perceived time pressure* • *The A320 incident AAIB report stated that "The 07:00 hrs estimated time to service originally established was entirely unrealistic, placing unnecessary additional pressure on the engineers to expedite the task"* • *The UK CAA ELD Newslink Issue 2 (July 99)* • *CHIRP Feedback issue 45, 46 p3.*
Personal performance: eyesight hearing physical condition	• can lead to incomplete work and / or poor quality due to lack of personal perception /awareness • *The UK CAA AWN47 provides guidance concerning eyesight, hearing and fitness, highlighting some of the adverse affects on performance which can occur if these are inadequate."* • *BAC1-11 - failure to use reading glasses*
Repetitive tasks *eg. visual inspection*	• repetitive tasks may lead to complacency / distraction and thus cause errors • *Aloha accident - visual inspection*
culture issues	• intercultural problems may lead to lack of communication between personnel of different origin

Part 2 Additional Organisational Issues not already covered above:

Issue	Justification
Design : manufacturer's documentation maintainability no Maintenance Manual validation	• Manuals not followed or difficult to follow because of poor quality • Cross connections and other design deficiencies have been major contributing factors in past accidents and incidents • *MSc thesis (Dohertey S) - many examples of cross connection problems/ incidents* • *Note: B777 did have its manuals validated and over 1000 changes were needed* • *AirFrance validated an A320 MM and over 2000 changes were needed* • *the A320 incident AAIB report stated that "industry must ensure that it has in place effective, rapid support, including usable systems for consultation with the design authority"* *Dutch incident - 5995*
Inspection	• History has shown double inspection helps capture maintenance errors • *BAC1-11 windscreen accident - no duplicate inspection required* • *The A320 incident AAIB report stated that "the duplicate inspecting engineer sought the requirements for the duplicates and functions from the dayshift engineer rather than consult the MM; this appears to be accepted practice but compromises the independence of the duplicate inspection"* • *Examples from Germany, eg. to check that static port covers have been removed after painting; tightening of nuts of a limited height and in a confined space now requires two people - one to check that an appropriate tool is being used, etc*
Shift / Task handover (note the training aspect is covered under "communication")	• Shift/task handover is known as an important issue as it could lead to incomplete maintenance if not properly performed. Criticality is 1 because bad shift handover is known to have been a major contributing factor in an aircraft accident • *A320- shift handover was verbal; paperwork was not complete; misunderstanding arose* • *B737-400 oil pressure loss incident - the line engineer had intended to complete the task himself therefore did not make a written statement or annotation on a work sheet to show where he had got to in the inspection, and the verbal handover was not adequate* • *A320 incident - handovers were verbal only, and ineffective* • *Incidents from Germany, eg. failure to communicate that a system has been de-activated/ re-activated*
Signing off tasks not seen/ checked	• Incidents • *737-400 oil pressure loss incident, Feb 95* • *Examples from Germany: greasing of landing gears; checking of proper adjustment of engine control cables by installation of rig pins. etc*

Issue	Justification
Shortage of engineers	• UK Royal Aeronautical Society paper; "The challenge for the future", highlights the problem of current and future shortage of aircraft maintenance engineering staff, stating that there exists:"a significant shortage of appropriately skilled labour due to a contraction of the supply of skilled personnel from the armed services, manufacturing sectors, and the traditional airline apprenticeship schemes". • The UK Government Transport Sub-Committee of the Environment, Transport and Regional Affairs Committee (ETRAC), have stated: "we are extremely concerned about the shortage of maintenance engineers, both in the Commercial and general Aviation sectors". • In 1998, the President of Embrey Riddell University, in the USA, stated: "The worldwide shortage of skilled and trained aviation maintenance technicians has reached a critical stage. Predictions indicated that this shortage will continue to worsen as the active fleet is growing while the number of individuals preparing for an aviation maintenance career declines" • *Anecdotal evidence from industry* • *Incidents where there are reports of licensed engineers having to work long hours due to staff shortages* • *BAC1-11 windscreen incident - short staffed* • *A320 locked spoilers incident- LAE requested extra help but none was available* • *B737-400 oil pressure loss incident - staff shortages*
tools & equipment *& documentation*: design accessibility availability	• poor design, accessibility and availability of tools and equipment may lead to poor work performance because personnel must fight adverse situation rather than concentrate on job performance • *A320 - tooling supplied was deficient or incorrect; no collars for locking spoiler* • *Examples from Germany: non-availability of the correct AMM, CMM, IPC; no documentation for dome jobs*
Workplace : lighting temperature / climate noise	• Inadequate working conditions may lead to poor work performance because personnel must fight adverse working condition rather than concentrate on job performance. • *B737-400 poor lighting conditions* • *Germany - non-detection of cracks because of poor lighting; repair of components in a dusty area leading to malfunctions after a short time of operation; a listening check of the flight controls cannot be completed due to riveting noise*
Computerisation	• introduction of a computerised system which was not ‘ready’ - leading to problems • *Germany - computer system for entry and rectification of findings out of service for hours or days*

Attachment 3

Establishment of an Occurrence Management Scheme

1. Introduction

NPA 145-10 introduces a requirement for an internal occurrence reporting scheme. This document provides guidance material concerning how such a scheme may be set up and run effectively.

2. Key elements for the establishment of an occurrence management scheme.

Note: guidance is provided for an Occurrence Management Scheme (OMS), of which occurrence *reporting* is just one element.

2.1 Prevailing industry best practice has shown that an OMS should contain the following elements:

- Clearly identified aims and objectives
- Demonstrable corporate commitment with responsibilities for the OMS clearly defined
- Corporate encouragement of uninhibited reporting and participation by individuals
- Disciplinary policies and boundaries identified and published
- An occurrence investigation process
- The events that will trigger error investigations identified and published
- Investigators selected and trained
- OMS education for staff, and training where necessary
- Appropriate action based on investigation findings
- Feedback of results to workforce
- Analysis of the collective data showing contributing factor trends and frequencies

2.2 The aim of the scheme is to identify the factors contributing to incidents, and to make the *system* resistant to similar errors. Whilst not essential to the success of an OMS, it is recommended that for large organisations a computerised database be used for storage and analysis of occurrence data. This would help enable the full potential of such a system to be utilised in managing errors.

2.3 An occurrence management system should enable and encourage free and frank reporting of any (potentially) safety related occurrence. This will be facilitated by the establishment of a just culture. An organisation should ensure that personnel are not inappropriately punished for reporting or co-operating with occurrence investigations. Further information is given in para 3.1

2.4 A mechanism for reporting such occurrences should be available. Further information is given in para 3.2

2.5 A mechanism for recording such occurrences should be available. Further information is given in para 3.3

2.6 Significant occurrences should be investigated in order to determine causal and contributory factors, ie. why the incident occurred. Further information concerning which incidents should be investigated, and how, is given in para 3.4.

2.7 The occurrence management process should facilitate analysis of data in order to be able to identify patterns of causal and contributory factors, and trends over time. Further information is given in para 3.5.

2.8 The process should be closed-loop, ensuring that actions are taken to address safety hazards, both in the case of individual incidents and also in more global terms. Further information is given in para 3.6.

2.9 Feedback to reportees, both on an individual and more general basis, is important to ensure their continued support for the scheme. Further guidance is given in para 3.7.

2.10 The process should enable data sharing, whilst ensuring confidentiality of sensitive information. Further information is given in para 3.8.

3. Detailed Guidance

3.1 Just culture code of practice

3.1.1 Organisations are encouraged to adopt the following code of practice to establish a just culture and encourage occurrence reporting:

3.1.2 Where a reported occurrence indicates an unpremeditated or inadvertent lapse by an employee, as described below, an organisation would be expected to act reasonably, agreeing that free and full reporting is the primary aim in order to establish *why* the event happened by studying the contributory factors that led to the incident, and that every effort should be made to avoid action that may inhibit reporting.

3.1.3 It is recognised that whilst the majority of actions should not incur remedial or punitive action, there will be some situations where such action is necessary. A rule of thumb is to use the 'substitution test' whereby if, under similar circumstances, another individual who was similarly trained and experienced would probably have made the same error, then punitive action is generally inappropriate. Each organisation should establish a code of practice, and publish this to employees.

3.1.4 An unpremeditated or inadvertent lapse should not incur any punitive action, but a breach of professionalism may do so. As a guideline, individuals should not attract punitive action unless:

(a) The act was intended to cause deliberate harm or damage.

(b) The person concerned does not have a constructive attitude towards complying with safe operating procedures.

(c) The person concerned knowingly violated procedures that were readily available, workable, intelligible and correct.

(d) The person concerned has been involved previously in similar lapses.

(e) The person concerned has attempted to hide their lapse or part in a mishap.

(f) The act was the result of a substantial disregard for safety.

"Substantial disregard", for this purpose, means:

-In the case of a certification authorisation holder (e.g. licensed engineer or Certifying Staff) the act or failure to act was a substantial deviation from the degree of care, judgement and responsibility reasonably expected of such a person.

-In the case of a person holding no maintenance certification responsibility, the act or failure to act was a substantial deviation for the degree of care and diligence expected of a reasonable person in those circumstances.

3.1.5 The degree of culpability would vary depending on any mitigating circumstances that are identified as a result of the occurrence investigation. It follows that any action taken by the organisation would also be on a sliding scale varying from corrective measures such as re-training through to dismissal of the individual.

3.1.6 Organisations should publish their disciplinary policy, making it known to all employees.

3.2 Processes for reporting occurrences

3.2.1 The reporting mechanism should be made as easy as possible for reportees, requesting as much key information as is necessary whilst not placing an undue burden upon reportees to give too much detail. Avoid requesting unnecessary information. Avoid unnecessary duplication of forms. The reporting mechanism should be as flexible as possible to encourage employees to report (eg. via free-text letter, structured paper forms, via computer, via e-mail, via phone, face-to-face, etc), whilst taking into account the requirements of those who may need to investigate the incident or analyse the data. Inevitably a compromise will be necessary.

3.2.2 It is likely that the reporting mechanism will already be prescribed, partially or wholly, by the existing mandatory reporting requirements or by an existing company reporting scheme.

3.2.3 Reporting should be confidential but not anonymous, since it may be necessary to contact the reportee to obtain more information about the occurrence.

3.2.4 Further guidance as to appropriate mechanisms for reporting, and how to ensure confidentiality, may be obtained from various sources, including organisations which have successful schemes in place and from the Global Aviation Information Network (GAIN) programme (www.gainweb.org)

3.3 Processes for recording occurrences

3.3.1 There are numerous processes and tools in existence to assist with the recording of occurrence data. These generally involve some form of classification scheme or taxonomy, such that the information may be recorded in a structured fashion. These range from processes which record just basic data, such as date, time, location, etc., leaving the remaining data in free text form, to processes where there are many specific categories and keywords, with all the data being classified according to a rigid structure.

3.3.2 Existing schemes for general occurrence data recording include: ICAO's ADREP, ECCAIRS, UK CAA's MORS, USA's ASRS, UK's CHIRP, etc.

Existing schemes for recording of maintenance-related occurrences include: MEDA, the ADAMS classification scheme, etc.

3.3.3 When choosing a process, organisations should take into account many factors such as:

(a) is one general process, suitable for recording all occurrences, required?

(b) what level of detail of recording is necessary?

(c) is compatibility with any other scheme (eg. NAA) necessary?

(d) analysis needs - what you want to get out may dictate how you code the data in the first place

(e) links with other company processes, eg. health and safety monitoring, Quality Assurance, etc.

(f) existing products/ tools, and their cost.

3.3.4 The prime criterion for the selection of an occurrence recording process should always be to enable an organisation to better understand safety hazards in order to be able to better control the risks.

3.4 Investigation of occurrences

3.4.1 The reporting scheme should encourage reportees to try to identify causes and contributory factors, but further investigation will be necessary in some cases. Ideally, all those occurrences for which the cause or contributory factors are not known, should be investigated. However, this may be too resource intensive, so an organisation may wish to set certain criteria, usually related to the significance of the incident, to determine which occurrences are investigated.

3.4.2 Investigation processes can vary considerably in depth and nature. Organisations are encouraged to adopt the MEDA investigation process as a model, since this is the most widely used process in the maintenance industry currently. Further information can be obtained from the "Human Factors and Aircraft Maintenance Handbook".

3.5 Data analysis

3.5.1 Analysis of occurrence data is encouraged in order to better identify patterns of causal or contributory factors, and to determine trends over time. An electronic database can assist greatly in this process.

3.5.2 Various analysis tools are available. Further information can be obtained from the "Human Factors and Aircraft Maintenance Handbook".

3.6 Managing identified hazards

3.6.1 Once hazards are identified (including both actual and potential hazards), a risk assessment should be made of the causes and contributory factors, and a decision made as to whether action is required. Action may be in the form of a change (eg. to a procedure, issue of a notice, personnel action, etc) or merely monitoring the situation to determine that the risk is controlled. Changes should address both the root causes of hazards and the detection and trapping of problems before they can jeopardize flight safety. Actions which are inappropriate to the cause of the problem (eg. 'blame and train') may result in the ORS losing credibility among staff. The occurrence management process should be closed-loop in order to ensure that actions are identified and carried out.

3.6.2 An ORS should record actions taken in respect of previous occurrences, so that managers may look at the effectiveness (or otherwise) of the remedial action(s) in the event of a repetition of an occurrence. Alternative action may be appropriate if the remedial action has previously been ineffective.

3.7 Feedback

3.7.1 Feedback should be given to the workforce and to original reportees concerning actions, to encourage continued future reporting. A magazine can be an effective way of providing feedback to the workforce in general, although care needs to be taken not to breach confidentiality and to disidentify occurrences. The most effective feedback is that which shows that something has been changed for the better as the result of an occurrence report or investigation.

3.8 Sharing of results

3.8.1 Information should be effectively promulgated to those individuals and organisations who may need to act upon the results, including own employees, contracted staff, sub-contracted organisations, operators, suppliers, manufacturers and regulators.

3.8.2 ACJ 20.XX addresses data exchange between maintenance organisations and manufacturers & operators.

3.8.3 Organisations are encouraged to share their occurrence analysis results with other maintenance organisations.. However, it is appreciated that some information in an occurrence database may be considered sensitive to the organisation affected, and may need to be dis-identified before being shared with other organisations.

3.8.4 Information sharing may be accomplished on an informal or formal basis, and can range from regular discussions between organisations concerning possible common problems, to electronic data exchange arrangements, whereby all the organisations who have agreed to exchange data can look at one another's databases (usually at a level where confidential details are disidentified). BA's Safety Information Exchange (SIE) is one such example.

3.8.5 Further information concerning data exchange can be found in the "Human Factors and Aircraft Maintenance Handbook", or obtained from Global Aviation Information Network (GAIN) (www.gainweb.org)

4. Applicability according to size of organisation

4.1 All the principles described in this Guidance Material are applicable to all JAR-145 approved organisations. However, it is recognised that the mechanisms to enable these principles to be put into practice may differ in terms of their appropriateness to different sized organisations. For example, it would be appropriate for a large organisation to have a computerised database, but this my not be necessary for a small organisation. The important point is to ensure that occurrences are reported, investigated, risks identified and action taken to control those risks; how this may best be accomplished may vary from organisation to organisation.

Human Factors Principles for the Design of Procedures

1. Introduction

Investigation of maintenance related incidents has shown that many procedures are poorly written or presented. Whilst it is important that the manufacturers' data is incorporated accurately within the procedures, this information can be presented well or poorly, depending upon the skill of the procedure writer and the extent to which the procedure is revised based on experience and practice.

2. The following guidelines may assist in the production and amendment of procedures:

2.1 Procedure design and changes should involve maintenance personnel who have a good working knowledge of the tasks.

2.2 All procedures, and changes to those procedures, should be validated before use where practicable

2.3 Ensure procedures are accurate, appropriate and usable, and reflect best practice

2.4 Take account the level of expertise and experience of the user; where appropriate provide an abbreviated version of the procedure for use by experienced technicians.

2.5 Take account of the environment in which they are to be used

2.6 Ensure that all key information is included without the procedure being unnecessarily complex

2.7 Where appropriate, explain the reason for the procedure.

2.8 The order of tasks and steps should reflect best practice, with the procedure clearly stating where the order of steps is critical, and where the order is optional.

2.9 If the order of steps is not already dictated, consider ordering the steps according to logic, or space (eg. working around the aircraft sequentially, as with a pilot's checklist), as opposed to alphabetical or ATA chapter order.

2.10 Group step into 'chunks' and plan for interruptions. Train staff to complete a 'chunk' of steps before allowing themselves to be interrupted, and design the procedure such that it can be marked when and where an interruption occurs

2.11 ensure consistency in the design of procedures and use of terminology, abbreviations, references, etc.

2.12 Print should be clear, with a plain font being used (eg. Times New Roman, Arial) with a size of 12 point recommended (minimum 10 point) for text, and 14 point for headings.

2.13 Coloured paper is not recommended as it does not photocopy well. Black ink on white paper is recommended

2.14 Use of colour for primary coding should be avoided, since the colour is lost when photocopies are made. However, colour can be a useful aid to clarity, especially in diagrams and photos, if used redundantly or if not essential.

2.15 Where possible, try to ensure that a complete procedure, or chunk of information, is on one page. Where a procedure runs to more than one page, make this clear.

2.16 Use standard sized pages (A4 or A5 in Europe)

2.17 Include clear titles at the top of each page and section of the procedure. Where the procedure has been changed, highlight this change where appropriate (with a line or the letter 'R' at the side of the page), and note the revision date at the bottom of the page.

2.18 Cross referencing should be avoided where possible. This may require steps to be repeated in several places (note: the drawback of this is that any changes have to be made in several places also).

2.19 Logical flow should be clear, using a flow chart if necessary. If procedures include options and branches, care should be taken that the path through the procedure is clear, especially if the user is required to return to an earlier point in the procedure after having actioned a set of steps. This can be particularly important in troubleshooting.

2.20 Group associated steps on the page; separate non-associated steps on the page. Use blank lines or spaces appropriately.

2.21 Use emphasis (eg. italics, bold) consistently. Avoid over-use of uppercase for emphasis; lower case is easier to read. Avoid over-use of italics, reserving this for single words or short phrases only, or for notes. Boxing is useful to distinguish very important steps or chunks from less important steps or chunks

2.22 A diagram or photograph can be very useful and can communicate large amounts of information efficiently. However, care must be taken with their use, ensuring:

- it is correct (a diagram of a similar piece of equipment which is not exactly the same, can cause more confusion that help)
- it photocopies well (if photocopying is likely to take place)
- the fine detail can be read in the lighting conditions under which it will be used
- it is orientated appropriately
- it is labelled appropriately
- the diagram/photo is clearly linked with a procedure/step

2.23 Insert warnings and notes into the procedure wherever necessary, without unduly detracting from clarity, to ensure safe and accurate performance

2.24 Consider the use of warnings, cautions or notes to highlight important points and steps where errors are likely (information from the internal error management scheme should identify error-prone procedures and steps).

2.25 Distinguish between directive information, reference information, warnings, cautions, notes, procedures and methods

2.26 Use cautions and warnings directly above the text to which they refer, or, where this is inappropriate, clearly link the text and the warning or note. Use notes after the related text.

2.27 Cautions, warnings and notes must be on the same page as the text to which they refer.

2.28 Where practical, build in check boxes into the procedure to enable and encourage the user to check off steps as they are completed.

2.29 Clearly link the check box with the associated step, eg. using dotted lines.

2.30 Allow enough space if information needs to be entered

2.31 Stress the importance of clear handwriting if written information needs to be handed over to another person.

2.32 Ensure that printing and copy quality is good, and that there are enough printers, copiers, etc.

2.33 Provide training on the use of technology to access and print procedures and maintenance data.

Minimising the Occurrence of Fatigue

1. Introduction

Approved Maintenance Organisations should take account the limitations of human performance when planning maintenance tasks.

Some specific guidance on how to minimise the fatigue of shift personnel is provided below:.

2. Shift personnel fatigue may be minimised by:

- Avoiding excessive working hours
- Allowing as much regular night sleep as possible;
- Minimising sleep loss;
- Giving the opportunity for extended rest when night sleep has been disrupted;
- Taking into account reduced physical and mental capacity at night;
- Taking into account individual circumstances;
- Providing organisational support services;
- Giving the opportunity for recovery.
- Rotating shifts toward the biological day, i.e., rotate to later rather than earlier shifts.
- Minimising night shifts through creative scheduling
- Providing longer rest periods following night shifts
- Within a week providing longer continuous rest periods when the week includes more than 2 night shifts

3. The impact of fatigue may be minimised by:

- Allocating more critical tasks during day shifts when staff are likely to be more alert
- Ensuring that appropriate checks are carried out after night shift work
- Breaking up lengthy repetitive tasks into smaller tasks, with breaks in between

Intentionally Left Blank

Syllabus for initial Maintenance Human Factors Training

1. General / Introduction to human factors

1.1 Need to address Human Factors

1.2 Statistics

1.3 Incidents

2. Safety Culture / Organisational factors

3. Human Error

3.1 Error models and theories

3.2 Types of errors in maintenance tasks

3.3 Violations

3.4 Implications of errors

3.5 Avoiding and managing errors

3.6 Human Reliability

4. Human Performance & Limitations

4.1 Vision

4.2 Hearing

4.3 Information-Processing

4.4 Attention and Perception

4.5 Situational awareness

4.6 Memory

4.7 Claustrophobia and physical access

4.8 Motivation

4.9 Fitness/Health

4.10 Stress

4.11 Workload management

4.12 Fatigue

4.13 Alcohol, medication, drugs

4.14 Physical work

4.15 Repetitive tasks / complacency

5. Environment

5.1 Peer pressure

5.2 Stressors

5.3 Time pressure and deadlines

5.4 Workload

5.5 Shift Work

5.6 Noise and fumes

5.7 Illumination

5.8 Climate and temperature
5.9 Motion and vibration
5.10 Complex systems
5.11 Hazards in the workplace
5.12 Lack of manpower
5.13 Distractions and interruptions

6. Procedures, Information, Tools and Practices

6.1 Visual Inspection
6.2 Work logging and recording
6.3 Procedure – practice / mismatch / Norms
6.4 Technical documentation – access and quality

7. Communication

7.1 Shift / Task Handover
7.2 Dissemination of information
7.3 Cultural differences

8. Teamwork

8.1 Responsibility
8.2 Management, supervision and leadership
8.3 Decision making

9. Professionalism and integrity

9.1 Keeping up to date; currency
9.2 Error provoking behaviour
9.3 Assertiveness

10. Organisation's HF Program

10.1 Reporting errors
10.2 Disciplinary policy
10.3 Error investigation
10.4 Action to address problems
10.5 Feedback

Attachment 7

Detailed guidance on initial Human Factors training

1. Introduction

1.1 The JAA Maintenance Human Factors Working Group proposed to include in JAR 145 a Human Factors training syllabus intended for all maintenance organisations. This syllabus was left intentionally very general in order to provide the necessary flexibility to the maintenance organisation to adapt it to its own size and scope of work. Furthermore it was considered that training on human factors being a new subject for the biggest part of the maintenance industry, experience should be first gained on the issue before making a prescriptive requirement. On the other end, it is acknowledged that additional guidance is certainly needed to develop an effective maintenance human factors training programme. This document includes such a guidance, but it is recommended to use it with the necessary flexibility during the first years of implementation of the requirement. This means that deviation from this guidance material should be accepted if appropriate justifications (size, scope of the organisation, etc..) are provided.

1.2 JAR 66 already includes a requirement for examination on Human Factors for applicant to a JAR 66 Aircraft Maintenance Licence (AML). It should be noted that while JAR 66 does not include any training requirement but only examination requirement on Maintenance Human Factors, those applicant to a JAR 66 AML trained by a JAR 147 approved training organisation would have undergo a training course on Maintenance Human Factors. This document includes a proposal on possible credits against JAR 145 Human Factors training that could be granted to JAR 66 AML holder. The Working Group proposes that examination credits against JAR 66 Appendix 1 Module 9 be granted to those applicant already trained on Maintenance Human Factors in accordance with this Guidance Material.

1.3 Finally this document provides additional guidance on which categories of maintenance personnel should undergo Human Factors training, training methods, training duration and requirements for trainers

2. Aim and objectives of Maintenance Human Factors training

2.1 The aim of Human Factors training is *to increase safety, quality and efficiency in aircraft maintenance operations by reducing human error and its impact in maintenance activities*. This is obtained through the integration of appropriate categories of maintenance personnel's technical knowledge and skills with basic human factors knowledge and skills and promotion of a positive attitude towards safety.

2.2 The objectives of Human Factors training are:

- To enhance maintenance personnel's' awareness of individual and organisational human factors issues, both positive and negative, that may affect airworthiness.
- To develop human factors skills (such as communication, effective teamwork, task management, situational awareness, writing of procedures) as appropriate to the job, in order to make a positive impact on the safety and efficiency of maintenance operations.
- To encourage a positive attitude towards safety, and to discourage unsafe behaviour and practices.

3. Categories of staff to be trained on Maintenance Human Factors.

3.1 Categories of staff to be trained on Maintenance Human Factors include all personnel of a JAR 145 approved maintenance organisation whose work has a direct or indirect affect on the safety of the aircraft or compliance with JAR 145; this means, but not exclusively, the following categories of personnel:

(a) Post-holders, managers, supervisors

(b) Certifying staff, technicians, and mechanics.

(c) Planners, engineers,

(d) Quality control/assurance staff

(e) Specialised services staff

(f) Human factors staff/ Human factors trainers

(g) Store department staff, Purchasing dept. staff

(h) Ground equipment operators

(i) Contract staff in the above categories

4. Duration of training

4.1 The duration of training will vary depending on the category of personnel involved, for example a typical training course duration would range from 1 day for managers and up to 2-3 days for certifying staff.

4.2 Although training courses may be tailored for certain categories of personnel, consideration should also be given to the benefits of having combination of personnel from different functional groups during training sessions.

5. Continuation training

Continuation training may take the form of a dedicated course or, alternatively, may be integrated into other training or company processes.

The aim of the continuation training is to:

(a) Refresh those topics of the Human Factors Training Syllabus that are most significant for the organisation;

(b) Further develop skills (communication, team work, task management, situational awareness, etc) as appropriate to the job;

(c) Make staff aware of human factors issues identified from internal or external analysis of incidents/ occurrences, including instances where staff failed to follow procedures and the reasons why particular procedures are not always followed, reinforcement of the need to follow procedures and the need to ensure that incomplete or incorrect procedures are identified to the company in order that they can be corrected. This does not preclude the possible need to carry out a quality audit of such procedures.

6. Requirements for trainers.

6.1 Human Factors training shall be conducted by at least one Human Factors trainer nominated by the Approved Maintenance Organisation, who may be assisted by experts in order to address specific areas. Trainers should meet the following requirements:

(a) Have attended an acceptable Human Factors training course that covers the JAR 145 initial training syllabus,

(b) Have received additional instruction in training and facilitation techniques,

(c) Have worked for at least 3 years for a maintenance organisation, in the case of continuation training.

6.2 Training could be provided by either a trainer employed by the organisation or by trainers outside the organisation, although training is likely to be most effective if it is tailored to the specific needs and problems of one's own organisation and the instructor is someone familiar with the needs and problems of that organisation.

7. Training methods

7.1 Consideration should be given to the use of different training methods and tools including classroom training, group discussions, accident/ incident analysis, case studies from one's own organisation, video, role-play exercises, teamwork exercises etc

8. Training credits

8.1 A requirement already exists within JAR 66 to demonstrate knowledge of the elements included within the Module 9 (human factors) syllabus. This is tested by means of examination.

8.1.1 The concern is that the emphasis within JAR 66 Module 9 will be upon those aspects of human factors which can be examined, rather than upon the organisational and safety culture aspects of human factors which are more important to safety in a maintenance organisation.

8.1.2 Accordingly it is considered that an appreciation of human factors can only be obtained by training, ideally within the context of the organisation within which the people work.

8.1.3 It is not the intention of either JAR 66 or JAR 145 to have unnecessary overlap in terms of human factors training, therefore 'credits' should offered whereby:

(a) personnel having been certified under a JAR66 license incorporating Module 9 (human factors) only after having received human factors training within a JAR147 organisation, are exempted from those modules common to the JAR66 module 9 syllabus and the JAR145 Human Factors training syllabus.

(b) personnel having been certified under a JAR66 license incorporating Module 9 (human factors) who have not received human factors training within a JAR147 organisation, are required to complete JAR 145 initial human factors training, without any exemptions.

(c) personnel having completed a JAR 145 human factors course meeting the criteria of this Guidance Material, are exempted from the JAR 66 Module 9 examination.

(d) personnel having completed a human factors course below the criteria of this Guidance Material, are not exempted from the JAR 66 Module 9 examination.

9. Training Syllabus for Human Factors

9.1 Introduction

9.1.1 Taking into consideration the general training objectives, the Training Syllabus table identify the topics and subtopics to be addressed during the Human Factors training (column 2 & 3).

9.1.2 For each training topic specific objectives are defined (column 4). These objectives are specified in term of knowledge (to know), skills (how to do), attitude (how to be) according to the principle that effective Human Factors training, besides improving the knowledge of the trainees, should foster behavioural skill developments and attitude changes:

(a) Knowledge objectives (K), knowledge and understanding of factual information that should be acquired during the training;

(b) Skill objectives (S), development of skills which may be applied in the workplace, eg., problem solving, decision making, communication, team-work, stress coping strategies, workload management.

(c) Attitude objectives (A), development, change or re-inforcement of a safety conscious attitude, eg., following procedures, using reference data rather than relying upon memory, checking work rather than assuming that it has been done properly, resisting pressure to cut corners when under time constraints, etc.

9.1.3 The last column (column 5) gives examples related to the objectives which organisations may wish to incorporate in their human factors training.

9.1.4 The Training syllabus refers to Initial Human Factors training .For continuation training, Topics and related Objectives can be selected taking into consideration the criteria given in the AMC.

9.1.5 The maintenance organisation may combine, divide, change the order of any subject of the syllabus to suit its own needs, so long as all subjects are covered to a level of detail appropriate to the organisation and its personnel.

9.1.6 Some of the topics may be covered in separate training (health and safety, management, supervisory skills, etc.) in which case duplication of training is not necessary.

9.1.7 Where possible, practical illustrations and examples should be used, especially accident and incident reports

9.1.8 Topics should be related to existing legislation, where relevant (JAA/NAA/EU)

9.1.9 Topics should be related to existing guidance/ advisory material, where relevant (eg. ICAO HF Digests and Training Manual, UKCAA AWN47)

9.1.10 Topics should be related to maintenance engineering where possible; too much unrelated theory should be avoided.

Detailed guidance on initial Human Factors training

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
1	General / Introduction to human factors		K: Achieve a basic understanding of the meaning of the term "human factors" K: Recognize the contribution of human factors to aviation accidents K: Understand the goal of human factors training	• See ICAO HF Digests, including ICAO circular 253 • Definition(s) of human factors • ICAO SHELL model • "Dirty dozen" as a concept. • Well-known accidents where maintenance human factors has been the cause • Company incidents where HF has been the cause
1.1		Need to address Human Factors	A: Appreciate the need to understand and address human factors	• The statistic that 80% of accidents are due to human error • US statistics which indicate that 50% of recent accidents have featured maintenance HF problems • Human factors within the control of the individual, and those which are not.
1.2		Statistics	K: Become reasonably familiar with some of the well-known incidents and studies of incident data, where human factors have contributed. Understand why these incidents occurred	• See ICAO Circular 253 • Boeing, Pratt & Whitney in-flight shut-down causes, Reason/Continental - 89-91, UKCAA 1992, etc.
1.3		Incidents		• See ICAO Circular 253 • Accidents and incidents where maintenance human factors has been the cause: • Aloha, 1988 • BAC1-11 windscreen, 1990 • A320 locked spoiler, 1993 • B737-400 oil loss, 1995 • B747 engine drop, Narita, 1994 • NTSB accident reports as referenced on the *hfskyway* website

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
2	Safety Culture / Organisational factors		K: Achieve a good understanding of the concept of "safety culture" K: Understand what is meant by the "organisational aspects" of human factors A: Appreciate the vital importance of a good safety culture,. K: Identify the elements of a good safety culture	• Definition of "culture" and "safety culture" • Reason, J: The elements of a good safety culture: • ·Commitment from senior level • ·A just culture • ·A good error reporting scheme • ·An effective Maintenance Error Management Scheme (MEMS) • ·Flexibility • ·Training investment • ·Willingness to learn and to change if necessary • ·Respect for the workforce
3	Human Error		K: Appreciate that human error cannot be totally eliminated; it must be controlled K: Understand the different types of errors, their implications, avoiding and managing error K: Recognize where the individual is most prone to error, A: Guard against error	• Definition of human error • Types of errors in maintenance engineering - Accidents and incidents to illustrate. • Causes of errors • How to reduce errors and mitigate their consequences
3.1		Error models and theories	K: Achieve a reasonable practical knowledge of the main error models and theories	• A reasonable practical knowledge of the main error models (SRK, GEMS, Reason's slips, lapses, mistakes & violations), and how this knowledge can help in a practical context (eg. investigation of incidents)

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
3.2		Types of errors in maintenance tasks	K: Understand the main error types (eg. slips, lapses, mistakes) and how these differ from violations	• Types of errors which have contributed to accidents and incidents in the past. Well-known analysis studies, eg. Boeing, Pratt & Whitney in-flight shut-down causes, Reason/Continental - 89-91, UKCAA 1992, etc. • Types of errors in maintenance engineering - Accidents and incidents to illustrate. • Causes of errors • MEDA categories
3.3		Violations	K: Understand the different types and causes of violations A: Avoid violating procedures and rules A: Strive towards eliminating situations which may provoke violations	• Types of violations (J Reason) • The different types of violations, eg. routine, situational, optimising. • Violation provoking situations, eg.poor procedures which do not reflect best practice, inadequate time to do the job, inadequate manpower, etc
3.4		Implications of errors	K: Achieve a good understanding of well-known incidents in terms of errors leading to the incidents A: Appeciate that it is not errors themselves which are the problem, but their consequences if undetected or uncorrected	• Accidents, incidents, learning opportunities; errors detected/ not detected • Accidents, incidents, learning opportunities; errors detected/ not detected • What *could* have happened...
3.5		Avoiding and managing errors	K: Understand the different ways of reducing errors and mitigating their consequences	• Error management = error containment + error reduction. • Error management techniques • Practical methods for error reduction
3.6		Human Reliability	K: Basic understanding of the main human reliability concepts, and how these relate to risk assessment Note: this may only be applicable to managers	• Concepts of human reliability • Human Reliability Techniques, eg. HAZOP, MORT, HTA, THERP, etc. · • Quantitative and qualitative techniques • Human reliability in the context of risk assessment

Detailed guidance on initial Human Factors training

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
4	Human Performance & Limitations		K: Recognize the effect of physical limitations and environmental factors on human performance A: Appreciate that humans are fallible K. Achieve basic knowledge of when and where humans are vulnerable to error A: Recognize where self or others suffer, and ensure this does not jeopardize personal or aviation safety	• Many texts have been written on human performance & limitations for pilots - some of this material will also be relevant for maintenance personnel
4.1		Vision	K: Understand how vision, and visual limitations, affects your job A: Recognise the need to have adequate (corrected) vision for the task and circumstances	• Practical guidance on vision standards associated with jobs/ tasks (eg. avionics, driving on airports, close visual inspection, etc), and in certain conditions (eg. low light conditions)
4.2		Hearing	K: Be aware of the health and safety best practice regarding noise and hearing A: Appreciate that hearing is not necessarily understanding	• Practical guidance on the dangers of exposure to loud noise, and its effect on hearing, both temporary and permanent
4.3		Information-Processing	K: Obtain a basic familiarity with the key terms used to describe information processing (ie. perception, attention, memory)	• An overview of the information process – perception, attention, memory
4.4		Attention and Perception	K: Achieve a basic understanding of the meaning of attention and perception	• Models and theories of attention; single channel theory, cocktail party effect, etc. • Expectation - dangers of "seeing what you want to see" & "hearing what you want to hear" • Boredom and attention

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
4.5		Situational awareness	K: Understand the dimension of situational awareness S: Develop ways of improving situational awareness	• Concept of situational awareness in a maintenance engineering context. • Stages of situational awareness "Perception, understanding of the significance of what you see; determination of future implications."
4.6		Memory	K: Achieve a basic understanding of the different types of memory (sensory, short term, working, long-term) and how these may affect you at work. A: Appreciate that memory is fallible and should not be relied upon.	• The fallibility of human memory - sensory, short term, working, long-term. • Accidents and incidents where individuals have relied upon memory, rather than consulting written information.
4.7		Claustrophobia and physical access	A: Appreciate that claustrophobia, fear of heights, etc., may affect the performance of some individuals.	• Concepts of claustrophobia & fear of heights • Difficult physical access and awkward working positions - what can be done to help (eg. Boeing work, design for better access, etc.)
4.8		Motivation	K: Understand what motivates people and what de-motivates people, in a maintenance engineering context A: Appreciate the need to avoid misdirected motivation	• Main theories of motivation, eg. Maslow, Herzberg • Accidents/ incidents where someone has failed to apply correct procedures, but with good intentions • Misdirected motivation - the desire to cut corners in order to get things done
4.9		Fitness/Health	A: Develop willingness to admit when feeling unwell, and taking steps to ensure this does not affect safety	• How can illness, poor health, poor fitness adversely affect work performance and affect safety. • Practical guidance as to what an individual can do if feeling unwell, eg. ask to swap to a less demanding task, ask a colleague to check performance, take medication (but be aware of its effects), stay at home, etc

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
4.10		Stress	K: Recognize the basic concepts and symptoms of stress S: Develop different techniques and positive attitudes to cope with stress	• The difference between stress and stressors • Effects of stress on human performance; individual differences • Concepts of arousal; Yerkes-Dodson curve; one person's -ve stress is another person's +ve stress • Signs of stress • Reactions to stress - denial, dealing with minor tasks instead, deferring, etc
4.11		Workload management	K: Recognise the need to manage workload S: Develop methods to manage workload	• Accidents or incidents illustrating the consequences of poorly managed workload
4.12		Fatigue	K: Understand how fatigue can affect your performance, especially during shiftwork or when working long hours S: Develop ways of managing fatigue A: Develop a personal integrity not to work on safety critical tasks when unduly fatigued	• Concepts of sleep, fatigue and circadian rhythms • Effects on performance of sleep deprivation, interrupted sleep, inadequate REM sleep, poor placement of sleep, etc. • Equating fatigue to alcohol intake (see work by Drew Dawson) • Incidents where fatigue has been cited as a factor, eg. CHIRP reports
4.13		Alcohol, medication, drugs	A: Appreciate that alcohol, drugs and medication can affect your performance	• Guidance on the effects on performance, after taking alcohol, medication or illicit drugs (see UKCAA AWN47)
4.14		Physical work	K: Understand the effects of sustained physical work on overall performance, especially cognitive performance, in a maintenance engineering environment	

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
4.15		Repetitive tasks / complacency	K: Be aware of examples of incidents where repetitive tasks and complacency have been a factor S: Develop ways of avoiding complacency	• Types of repetitive tasks where complacency might be a factor; possible reasons; how to avoid it (eg. by having breaks, by increased probability of detecting a problem, by training, by selection, etc) • Accidents and incidents involving repetitive tasks (eg, visual inspection of rivets) • Techniques of developing to deal with complacency
5	Environment		K: Achieve a basic appreciation of how the physical and social environment can affecton human performance	• Introduction to how the physical and social environment can affect work performance, & personal and aviation safety. • Examples of accidents/ incidents where the environment was a factor (eg. Narita 747 engine drop)
5.1		Peer pressure	A: Appreciate the · importance of sticking to the rules, procedures and documents even if others aren't · importance of personal integrity · importance of avoiding placing peer pressure on others S: Develop assertive behavior appropriate to the job	• Concepts of peer pressure and conformity; concept of norms Examples of accident/ incidents where a bad norm was a factor, e.g. (i)Unwillingness to use written information because it is seen as a lack of technical knowledge, (ii) Lack of individual confidence, (iii) Not following safe operation procedures because others don't follow them
5.2		Stressors	K: Achieve a basic understanding of the concepts of stress and stressors, as related to the work environment	• What types of environmental stressors are there • Causes of stress; work, domestic, environmental, etc

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
5.3		Time pressure and deadlines	K: Recognise the dangers of · cutting corners · applying inappropriate deadlines · self-imposed, supervisor and management time pressures S: develop assertive behaviour appropriate to the job	• Accidents/ incidents where time pressures have been a factor, eg. BAC1-11 windscreen accident in 1990. • Recognition that commercial pressure exists in some areas. Stress the importance of not letting this interfere with the job, or doing things properly.
5.4		Workload	K: Understand the basic contributors to workload S: Develop [planning and organising ~~time management~~] skills.	• What constitutes workload; relationship between workload and stress; relationship between workload and arousal; overload and underload • Causes of high workload (eg. unrealistic deadlines, undermanning) and how these might be dealt with
5.5		Shift Work	K: Understand the basic concept of circadian rhythms as this relates to shiftwork. K: Be familiar with best practice regarding working hours and shift patterns S: Develop strategies to manage shiftwork.	• Circadian rhythms, sleep and shiftwork - relationships and effects on performance. • Circadian 'dips', and how to combat them • Shift patterns - pros and cons • Research concerning shiftwork and shift patterns • Good practices for shiftworkers - guidance concerning sleep, meals, etc. • EU Working Time Directive, and how it affects maintenance staff & shiftworkers
5.6		Noise and fumes	K: Be aware of the health and safety guidance concerning noise and fumes	• General effects of noise on performance (the issue is complex; do not go into too much detail) • Effect of noise on hearing - temporary or permanent damage • How to reduce noise (eg. noise insulation) and how protect hearing against noise (eg. ear muffs) • Effects of fumes on performance

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
5.7		Illumination	K: Be aware of the effects of lighting upon performance, especially visual performance	• Guidance as to what illuminations are appropriate for various tasks
5.8		Climate and temperature	K: Be aware of the effects of climate and temperature upon performance	• Effects of extremes in temperature and humidity upon performance; practical guidance as to what can be done to help, where such extremes are unavoidable
5.9		Motion and vibration	K: Be aware of the health and safety guidance concerning motion and vibration	• Examples where motion and vibration affect performance e.g. engine ground running, riveting, use of moving platforms.
5.10		Complex systems	A: Be aware of the implications of your actions upon other parts of the system	• Examples that steps in procedures which may not seem particularly important, may have implications elsewhere in the system of which you are not aware.
5.11		Hazards in the workplace	K: Be aware of the health and safety guidance concerning hazards in the workplace	• Overlap areas between Health and Safety principles and National legislation, and Human Factors. • The need to remain calm and collected in a difficult situation. Examples may include engine fires, surges during ground runs, personal injury or danger when operating aircraft systems.
5.12		Lack of manpower	K: Understand how take into consideration the available manpower when (i) scheduling/planning work. (ii) performing a task Note: this topic may not be applicable for all staff	• Accidents and incidents where lack of manpower was a contributing factor. • Importance of reviewing the manhour plan
5.13		Distractions and interruptions	S: Develop ways of managing distractions and interruptions	• Recognition that distractions and interruptions will always exist • Stress the importance of recording work as you do it, just in case you are interrupted. • Go a few steps backwards in a checklist after returning to a job

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
6	Procedures, Information, Tools and Practices		A: Appreciate the importance of having available the appropriate tools and procedures A: Appreciate the importance of following the procedures and using the appropriate tools. A: Appreciate the importance of checking work before signing it off A: Appreciate the need of reporting irregularities in procedures or documentation.	• Identify the dangers of people cutting corners if tools are not available, procedures are difficult to use, information difficult to access, etc • Stress that perceived short-term benefits are usually outweighed by actual long-term dis-benefits. • Formal practices vs 'custom and practice' - stress that the two should be the same • Accidents/ incidents where problems have occurred due to unavailability of information, poor procedures, lack of appropriate tools, etc. • Keeping maintenance information up to date: • Looking for updates, rather than assuming all changes have been incorporated into one source • Notifying the appropriate person/ department of any inaccuracies/ ambiguities in maintenance information • Sign-Offs: • The responsibilties for sign-offs Accidents/ incidents where work was signed off without being properly checked • Principles of good planning; the importance of good communication and feedback between planners and 'front-line' maintenance staff.

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
6.1		Visual Inspection	K: Understand the factors that affect visual inspections. S: Develop skills to improve visual inspections.	• Definition; differences between visual inspection and NDI/NDT, and human factors implications - awareness • Vision requirements for NDI - overview • What is meant by type 1 errors and type 2 errors • Accidents and incidents caused by poor visual inspection - eg Aloha Airlines • Factors affecting visual inspection, eg. age, vision standard, lighting, torch beam, task repetitiveness & monotony, task breaks, probability of detecting a fault, attitude, training, visual search pattern, etc.
6.2		Work logging and recording	A: Appreciate the importance of correct logging and recording of work	• Good practices concerning work logging and recording, and job aids/ good task card design, which can help • Accidents/ incidents where poor logging was a cause - plenty to choose from
6.3		Procedure – practice / mismatch / Norms	A: Be aware that norms exist and that it can be dangerous to follow them. K: Be aware of instances where the procedures, practices or norms have been wrong.	• The concept of norms; differences between a norm and a habit. • Positive and negative norms • Formal practices & policies vs 'custom and practice' - stress that the two should be the same • The importance of providing the technician with usable procedures; the dangers of people cutting corners if procedures are difficult to use. • Accidents/ incidents where problems have occurred due to poor procedures, procedure/ practice mismatches or bad norm.

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
6.5		Technical documentation – access and quality	A: Appreciate the importance of having a good standard of technical documentation in terms of access and quality. .S: Learn how to write good procedures which reflect best practice (note: this may not be applicable to all staff) S: Learn how to validate procedures (note: this may not be applicable to all staff)	• Overview of good and bad examples of technical documentation • Use of standardized English where appropriate • Importance of commonality of terms and abbreviations, especially where technicians are working on different types of a/c, eg. Boeing and Airbus. • Formats of information (eg. paper, photocopies, microfiche, computerised, etc) and their pros and cons. • Accidents/ incidents involving poor access to technical documentation, eg. Narita 747 engine drop.
7	Communication		K: Recognize the need for an effective communication at all levels and mediums. K: Understand the basic principles of communication. S: Develop skills for correct verbal and written communication appropriate to the job and context.	• Principles of good written communication; need for important information (eg. on shift handover) to be communicated both verbally and in writing. • OJT + classroom exercises, eg. domino exercise • Communication within and between teams
7.1		Shift / Task Handover	K: Detailed knowledge of some incidents where a poor handover has been a contributory factor A: Appreciation of the importance of good handovers S: Learn how to carry out a good handover	• Principles of good shift/task handover; verbal and written information exchange - built in redundancy; clear, thorough communication; need for shift overlap; etc. • OTJ + classroom exercises, eg. domino exercise • Accidents/ incidents involving shift handover deficiencies, eg. A320 locked spoiler incident, 1993.

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
7.2		Dissemination of information	A: Appreciate the importance of information being kept up-to-date, and being accessible by those who need it; important/urgent information getting to the people who need it	• Accidents/ incidents caused by poor information management
7.3		Cultural differences	A: Appreciate that cultural differences can affect communication.	• Cultural differences between countries; between companies; between types of maintenance (line & base); between shifts; between individuals, between pilots and maintenance personnel • Hofstede's work – differences between National cultures - but try to relate this to maintenance engineering.
8	Teamwork		K: Understand the general principles of teamwork. A: Accept the benefits of teamwork. S: Develop skills for effective teamwork . A: Believe that maintenance personnel, flight crew, cabin crew, operations personnel, planners etc should work together as effectively as possible.	• Concepts of Maintenance Resource management (MRM) • Where human factors and teamwork relate to maintenance • Effective work relationships • Motivation • Running meetings • Conflict management
8.1		Responsibility	A: Encourage a team concept, but without devolving or degrading individual responsibility	

Detailed guidance on initial Human Factors training

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
8.2		Management, supervision and leadership	K: Understand the role of managers, supervisors and leaders in teamwork. S: Develop management skills for appropriate personnel.	• Difficulties associated with doing both a management/ supervisory job, and 'hands-on' engineering • Incidents involving supervisors, and reasons why, eg. B737-400 oil loss incident. • Delegation, prioritisation of tasks • Leadership styles – use of authority or assertiveness
8.3		Decision making	S: Develop decision making skills based on good situational awareness and consultation where appropriate	• Explain the different phases of the decision making process.
9	Professionalism and integrity		K: Understand what is expected from individuals in terms of professionalism, integrity, and personal responsibility. A: Understand one's own responsibility to keep aviation safety standards high, and put this into practice at all times	• The general characteristics of a professional and how these fit to the aircraft maintenance profession • The contribution of aviation maintenance personnel to aviation safety • Abiding by rules and procedures, refusing to succumb to pressure, etc • Responsibilities of individuals, (eg. signing off work, inspecting tasks, reporting non-conformities, etc.) • Examples where cooperation between different aviation trades has contributed to the avoidance of incidents/accidents
9.1		Keeping up to date; currency	A: Accept the personal responsibility to keep up to date with necessary knowledge and information	• All personnel should read the applicable information from the organization such as revisions, memos,etc.
9.2		Error provoking behaviour	K: Achieve a good understanding of what constitutes error provoking behaviour. A: Appreciate the importance of avoiding the type of behaviour which is likely to provoke errors	• Give examples of error provoking behaviours (eg. cutting corners, failing to consult information, relying upon memory, working when fatigued, etc.) and strategies to avoid them.

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
9.3		Assertiveness	A: Appreciate the importance of being assertive.	• Give examples of assertive behaviour , e.g. refusing to sign off a job if it has not been completed properly, despite pressure from more senior people to do so.
10	Organisation 's HF Program		K: Achieve an depth understanding of the structure and aims of your company's HF programme. Note: if your organisation does not have all the elements of a HF programme, explain in general terms what these elements might be, ie: • Maintenance Error Management System • Links with Quality System • Links with Safety Management System • Disciplinary reporting and just culture • Top-level support • HF training for all staff • Action to address problems • Good safety culture	• Overview of the elements of your organisation's HF programme: • ·Commitment from senior level • ·Practical support from management • ·HF training for all staff • ·A just disciplinary policy • ·A good error reporting scheme • ·An effective Maintenance Error Management Scheme (MEMS), including (i)error investigation scheme (ii)analysis of problems; identification of improvements; acting upon recommendations (iii)feedback concerning problems and improvements (for guidance, see UKCAA AWN71) • ·Learning from accidents/ incidents/ previous occurrences; warning technicians of common errors/ problems so that they can guard against these; writing in warnings into the procedures
10.1		Reporting errors	A: Appreciate the importance of reporting incidents, errors, problems K: Understand what type of problems should be reported K: Understand the mechanisms of reporting	• Describe the reporting procedure.

Detailed guidance on initial Human Factors training

No.	Topic	Subtopic	Objectives for initial Training	Examples for initial training Contents
10.2		Disciplinary policy	K: Understand the organisation's disciplinary policy, and the circumstances under which disciplinary action may be appropriate, and when not A: Appreciate that you will not be unfairly penalised for reporting, or assisting with investigations	• Give each employee a copy of the company's disciplinary policy. • Use case studies to illustrate the policy. • Encourage group discussions concerning the policy
10.3		Error investigation	K: Understand the mechanisms of incident investigation	• • Explain what process your organisation uses, eg. MEDA • Consider using a worked example • Stress the importance of having trained investigators
10.4		Action to address problems	K: Understand the mechanisms of action to address errors	• Ensure staff are aware that reporting incidents will result in action
10.4		Feedback	K: Understand the mechanisms of feedback	• What feedback employees might expect from the MEMS. eg. company magazine, feedback to individuals involved in incidents, etc