REPÚBLICA DE MOÇAMBIQUE

INSTITUTO DA AVIAÇÃO CIVIL DE MOÇAMBIQUE

Technical Circular

CT 120-008 – HUMAN FACTORS IN THE DESIGN AND APPLICATION OF AN APPROVED MAINTENANCE PROGRAMME

Effectivity Date: 28/02/2016

SECTION 1 GENERAL

1.1 OBJECTIVE

This document contains guidance to be used by Mozambique Air Operator Certificate (AOC) holders and Approved Maintenance Organizations (AMO) for the consideration of human factors principles when designing and applying an approved continuous airworthiness maintenance programme. It also provides guidance on the development of a human factors training programme for the maintenance personnel.

1.2 APPLICABILITY

This TC applies to all Mozambican AOC holders and AMO certificate holders responsible for the design and application of an approved maintenance programme.

1.3 REFERENCES

(1) MOZCAR Parts 121, 127, 135 and 145;

(2) Doc 9824 Human Factors in Maintenance

1.4 CHANGES

(1) This is an original issue of this TC.

1.5 BACKGROUND

1.5.1 Maintenance errors contribute to a significant proportion of worldwide commercial aircraft accidents and incidents and these occurrences are costly.

1.5.2 With the majority of aircraft accidents and incidents resulting from less than optimum human performance, there has been a tendency to merely attribute them to human error. The term “human error” allows concealment of the underlying factors that must be brought to the fore if accidents are to be prevented. An error attributed to humans in the system may have been induced by inadequate design, inadequate training, badly designed procedures, and/or poor layout of job cards or manuals.

1.5.3 The understanding of Human Factors in aviation has progressively been refined and developed to include aircraft maintenance activities. A vast amount of knowledge is now available which can be used to ensure that operators and maintenance organizations reduce errors during maintenance.

1.5.4 The information in this TC has been extracted from ICAO Doc. 9824 where detailed guidance on Human Factors in aircraft maintenance may be found.

SECTION 2 HUMAN FACTORS PRINCIPLES IN THE DESIGN AND APPLICATION OF THE CAMP

2.1 General

2.1.1 To meet the applicable regulatory requirements the operator is responsible for ensuring that:

(1) The design of the maintenance programme observes Human Factors principles; and

(2) The application of the programme by the AMO observes Human Factors principles.

2.2 Document design for aircraft maintenance

2.2.1 The operator has the additional responsibility of designing a programme that observes Human Factors principles and providing this information in such a way that it can be applied by the AMO while observing Human Factors principles.

2.2.2 The design of a maintenance programme has two main aspects: first, the definition of actual work tasks and, second, the design and presentation of the programme document itself.

2.2.3 The actual maintenance work tasks and activities defined in the maintenance programme should take into account the following factors:

(1) The type of operation: short or long sectors which require different scheduling of tasks, e.g. a shortsector operation may break down the tasks into “packages” which can be performed overnight, whereas the long-sector operation requires a minimum of scheduled tasks over the operating days or weeks followed by a much larger maintenance work “package”;

(2) The geographical area of operation: e.g. operation in a high or low latitude with very short or long winter daylight hours where the high latitude will necessitate scheduling all tasks into a hangar to protect personnel from cold and to provide good lighting;

(2) The operator’s or AMO’s experience in operating or maintaining the aircraft type: e.g. personnel who are new to a particular type of aircraft are likely to require more time to perform tasks than those with considerable experience;

(3) The standards of aircraft type training provided to operating and maintenance personnel: e.g. personnel who have received a minimum level of training on the aircraft type are likely to require more time to perform tasks than those with more comprehensive training;

(4) The standard of competency of the AMO, its associated procedures and quality system: e.g. manpower planning should suit not only the actual tasks during a particular shift but also the actual available manpower; and

(5) The standard of competency of the operator’s organization and its associated procedures for the operation of the reliability programme (if applied to the aircraft type): e.g. an operator with a good standard of data collection, analysis and organization structure is likely to be able to take faster and better corrective action. As a result, the airworthiness of individual aircraft is likely to be higher.

2.2.4 An aircraft maintenance programme design that observes Human Factors principles should have the following features:

(1) Task or job sequences which are likely to reduce the probability or effect of error in its application (for example, performing engine maintenance with different work teams or between different flights);

(2) Work packages which suit an operator’s specific operation (for example, overnight packages); and

(3) Task or job cards or sheets which meet a standard for good document design.

2.2.5 Document design issues may be generically classified as follows:

(1) Information readability: This is a primary issue in document design and concerns the following two aspects: the typographic layout and the language structure. Both aspects have a significant effect on the reading speed and the accuracy of the material;

(2) Information content: This deals with the issues of both textual and graphic material. It is important that the material be appropriate, up to date, accurate, complete, easy to comprehend and unambiguous;

(3) Information organization: This refers to how information is organized in a document. In order that the information can be used by either expert or novice user, it should be classified into relevant categories and layered in terms of detail. The information also needs to be arranged in a logical sequence; and

(4) Physical compatibility: This relates to the handling and usage of a document. When designing a document, it is important to consider its physical compatibility with the task at hand. A work card, either of paper or a computer-based device, which has been degraded by weather or aircraft fluids or which is heavy, an unwieldy size, and/or incompatible with the local light levels, the tools used or with the task at hand, will not encourage use.

2.2.6 Guidelines intended to assist operators and maintenance organizations in the production and amendment of procedures are provided in Appendix A.

2.2.7 It is important that the manufacturers' data are incorporated accurately within the organizations' procedures.

2.2.8 Aircraft maintenance technical manuals prepared in accordance with the standards published by the Air Transport Association of America (currently ATA Specification 2200) are considered to be, in general, consistent with human factors principles.

2.3 Application of a CAMP

2.3.1 Features and results

2.3.1.1 In order to apply an aircraft maintenance programme so as to observe Human Factors principles, the AMO should have the following features, as appropriate to its scope and size:

(1) Satisfactory environment and ergonomics;

(2) Procedure documentation which meets a standard for good document design;

(3) Management that has satisfactory processes to achieve improvements in communication, effectiveness and safety in its operations (for example, these processes could include Maintenance Resource Management (MRM) and a quality system);

(4) Error management systems for reporting, investigating, analysing, measuring and taking corrective action; and

(5) Aircraft maintenance manuals (or equivalent documentation) which have been assessed to a standard for good document design.

2.3.1.2 The application of the operator's programme by the AMO should have the following results:

(1) Task instructions from the approved maintenance programme that can be either easily and accurately understood directly by AMEs or can be easily and accurately transcribed for them;

(2) Hangar or workshop environment and facilities that observe Human Factors principles;

(3) Procedures, instructions and practices that enable the AME (and other AMO staff) to apply the maintenance programme consistently and correctly and to release an aircraft or component that meets the type design and is in condition for safe operation; and

(4) All maintenance personnel having Human Factors knowledge and skills appropriate to the assigned tasks and responsibilities.

2.3.2 Maintenance Planning

2.3.2.1. Planning is vital to the successful application of a maintenance programme not only from a Human Factors viewpoint but also to ensure operational and economic efficiency. The primary aim should be to ensure that there are adequate appropriately qualified and alert

personnel, tools, equipment, material, maintenance data and facilities at the right place and at the right time for the scheduled (and, as far as is possible, the unscheduled) tasks.

2.3.2.2. Planning has two aspects:

(1) first, logistics planning for availability of parts and materials; and

(2) second, production planning which has the following two complementary elements:

(a) scheduling the maintenance work ahead to ensure that it will not adversely interfere with other maintenance work as regards the availability of all necessary personnel, tools, equipment, material, maintenance data and facilities; and

(b) organizing the maintenance teams and shifts during maintenance work and providing all necessary support to ensure the completion of maintenance without undue time pressure.

2.3.2.3 The planning system and procedures should consider, as a minimum, the following:

(1) logistics and inventory control;

(2) coordination with internal and external suppliers, etc.;

(3) square meters of workshop and/or hangar accommodation;

(4) hangar and/or workshop availability;

(5) estimation of man-hours;

(6) availability of man-hours;

(7) preparation of work; and

(8) scheduling of safety-critical tasks during periods when staff are likely to be most alert, and avoiding periods when alertness is likely to be very low, such as early mornings on night shifts.

2.3.2.4 The maintenance organization should have a maintenance man-hour plan showing that there are sufficient staff to plan, perform, supervise, inspect and quality monitor the organization. In addition, the organization must have a procedure to reassess work intended to be carried out when actual staff availability is less than the planned number for any particular work shift or period.

2.3.2.5. It is important that planners have Human Factors training in order to better appreciate how good or bad planning can potentially affect human performance and, ultimately, safety and airworthiness.

2.3.3 Shift Work

2.3.3.1 When setting shift patterns the aims of guidelines for “good practice” should be to:

(1) Minimize the build-up of fatigue over periods of work;

(2) Maximize the dissipation of fatigue over periods of rest; and

(3) Minimize sleep problems and circadian disruption.

2.3.3.2 Shift-work systems should be designed with the following principles in mind in order to minimize the effects of mental and physical fatigue:

(1) Provide regular opportunities for sufficient night sleep to prevent the accumulation of “sleep debt”;

(2) Provide a predictable shift system which allows workers to plan their schedule of rest and sleep to minimize sleep loss. Rotating shift patterns prevent this and should be avoided;

(3) Allow at least two successive nights’ sleep in order to allow for recovery from accumulated fatigue and sleep debt;

(4) Take account of reduced physical and mental capacity at night by avoiding the scheduling of such work under strong time pressures;

(5) Be flexible so as to take account of an individual’s ability to cope with the disruptions of shift work (e.g. age and domestic circumstances);

(6) Have the same support services available at night as during the day (e.g. administration, planning, quality, canteen/cafeteria and welfare);

(7) Allow opportunities for individuals to recover from conditions which give rise to fatigue and sleep loss; and

(8) Although overtime work is one option for completing tasks not completed during a shift, repeated overtime should be discouraged as it may possibly lead to reduced staff motivation and performance. The alternative is to pass the work to the next shift.

2.3.4 Task turnover/handover

2.3.4.1 Often it is necessary to hand a task over during a shift. Two common situations may arise:

(1) Unfinished task handed over to someone who is present at the time; and

(2) Unfinished task left for an unidentified person to take over at a later stage.

2.3.4.2 *Handing over a task directly to another person*. The process is done face to face using verbal and written communication. The written element is normally to ensure that the task cards or non-routine process sheets are accurately completed and clearly identify the stage at which the task has reached. Any deviations from normal working practices or procedures must be clearly highlighted during the walkthrough. For example, if when changing a valve, a clamp that was not required to be removed as per the maintenance manual was disturbed to aid removal and installation of the valve, this should be indicated.

2.3.4.3 *Handing over a task for somebody to complete at a later stage.* In such a case, it is often not known who will eventually take over the job of completing the task and certifying the release to service. This type of situation presents a far greater risk and challenge to effectively communicate the stage of task accomplishment and what remains to complete the job. Face-to-face communication is not possible. Everything depends on the written communication. There is no way to check the understanding of the person expected to finish the task.

2.3.4.4 *Scheduled Tasks*

2.3.4.4.1 Task cards are not usually designed to be used as a turnover/ handover document and are written assuming that the same person will start and finish the job.

2.3.4.4.2 Task cards break down jobs into discrete stages. Ideally, jobs should always be stopped at one of these stages so that the last sign-off on the card represents the exact stage at which the job has been reached. In this case, the card can be the turnover/handover document.

2.3.4.4.3 However, a job may be stopped at a point which is between the stages identified on the card, or the stage sequencing has not been followed or deviates from normal work procedures (such as in the example of disturbing the additional clamp to aid removal and installation of a valve).

2.3.4.4.4 When this occurs, additional written information must be used to clearly identify the point of exit from the task and what is required to complete the job and restore serviceability. Non-routine cards or sheets should then be used to record and transmit the necessary relevant information. The combination of both the task card and the non-routine worksheet should provide sufficient information for the person picking up the job to know the present status of the work and what is required to complete or continue it.

2.3.4.5 *Non-scheduled tasks*

2.3.4.5.1 All non-scheduled tasks intended to be performed on the aircraft or its components should be documented in such a way as to define the work to be accomplished. This is not only good maintenance practice but will facilitate the issue of a maintenance release on completion. Any task above the level of simple should be controlled by breaking down the work into discrete and documented stages with the provision for appropriately authorized staff to sign off or stamp when each step is completed.

2.3.4.5.2 The document used in this control process is often called a “stage sheet”. The stage sheet is particularly useful in the case of complex tasks or when there is a handover to another person or shift.

2.3.4.5.3 It also provides a record of who did what and when. Management and supervisors in maintenance organizations have a responsibility to ensure that there are formats, a procedure and adequate time for maintenance staff to record stages in this way.

2.3.5 Breaks and drinks

2.3.5.1 Short breaks in the task activity improve performance and reduce errors. A break of about 15 minutes every 2 to 3 hours is very beneficial to human performance.

2.3.5.2 Insufficient drinking of water is known to contribute to the symptoms of fatigue. Maintenance staff should have easy access to clean, potable water.

2.3.6 Examples of simple error avoidance measures

Tools, test equipment, parts.

2.3.6.1 Tools, test equipment, parts, etc. that are left on board an aircraft after maintenance have the potential to obstruct flight controls or affect other vital systems. The following are examples of arrangements, which alone, or in combination, can provide good control of these kinds of items:

(1) A shadow board or box for hand tools (wrenches, screwdrivers, etc.) that uses contrasting coloured outlines to provide a visual cue if a tool has not been replaced;

(2) Hand tools that are marked and are the personal property of the AME;

(3) Checklists for each AME’s toolbox and checked prior to aircraft release;

(4) Specific loose object area inspections prior to final panel closures; and

(5) Tool control via a stores loan system with personal “tool checks” or electronic card controls to identify the individual who has possession of a tool.

Separation of tasks

2.3.6.2 It is intended that separation of tasks will avoid the same error being made on other similar interventions by one person or one crew. An example is for the engine work or the engine maintenance work crew to be separated on multi-engined aircraft (used in EDTO).

Interruptions

2.3.6.3 Interruptions are a proven cause of maintenance errors. The following strategies may be used to control access to the work area:

(1) Having signs or other methods to ensure that casual company visitors are excluded from the aircraft and the area immediately surrounding it except by specific permission of a supervisor); and

(2) Arranging that personnel not physically working on the aircraft take incoming telephone calls.

Cross-connections

2.3.6.4 Systems which have been cross-connected have been reported on many occasions after maintenance activities. This has been noted on both electrical and fluid systems. The following are examples of “good maintenance practices”:

(1) Parts removed or disconnected should be tagged, labelled or colour-coded to aid correct reassembly;

(2) Company policy, procedure and training should emphasize the importance of functional testing when wiring or plumbing has been disturbed, whether this is specified in the manufacturer’s recommendations or not; and

(3) Any such cross-connection events should be reported to the appropriate aviation regulatory body and the TC holder for the product.

SECTION 3 HUMAN FACTORS TRAINING NEEDS AND OBJECTIVES

3.1 Target population

3.1.1 Experience to date suggests that similar baseline knowledge and competencies are required for all categories of maintenance organization personnel, in particular:

(1) Management personnel (senior, middle and supervisory);

(2) Accident/incident investigators;

(3) Personnel who certify aircraft and components for release to service;

(4) Instructors for Human Factors and some technical topics;

(5) Planning and maintenance programme engineers;

(6) AMEs and mechanics;

(7) Quality personnel (Quality Assurance and Quality Control);

(8) Stores department staff;

(9) Purchasing department staff;

(10) Ground equipment operators; and

(11) Contract staff in any of the above categories.

3.1.2 In addition, Human Factors trainers themselves will need a greater depth of knowledge, and specialist modules may be needed for other specific categories of personnel

3.1.3 In order to gain acceptance by trainees and to succeed, the Human Factors training for maintenance personnel needs to be based on sound, practical task-related principles. In particular, Human Factors training for maintenance personnel must:

(1) Be seen as valuable by the target population, from top management through to AMEs;

(2) Be able to demonstrate that it has made a real and measurable difference;

(3) Be responsive to feedback from recipients so as to improve the syllabus, instructors, and training techniques; and

(4) Reflect the differences in skill and background between the flight crew and AME populations

3.2 Training Needs

3.2.1 The primary objective of Human Factors training is to give all the above categories of personnel an understanding of how and why error is avoided when maintenance work is being performed.

3.2.2 Each category is exposed to, or creates the potential for, the risk of making an error. Human Factors training should therefore be adapted to suit the particular categories so that they can identify and avoid the potential opportunities for errors.

3.2.3 Managers and supervisors need knowledge on how working conditions influence the performance of personnel that plan and perform maintenance work on aircraft and their components. They need to be able to apply this knowledge and understand how their decisions and behaviour influence the attitudes of the personnel in the organization and their ability to perform their work with the minimum of potential risk of error.

3.2.3 Supervisors need to be aware of the local factors that present the potential for error. They should know how working conditions and the availability of correct tools and equipment can affect the attitude of the maintenance personnel and their approach to their work. Supervisors should be able to recognize and identify trends which indicate Human Factors-related risks.

3.2.4 Planners and engineers have a key role in the avoidance of Human Factors-related error. They must be able to write instruction documents that are not only technically correct but easy

to read, understand and are not ambiguous or open to interpretation. They need to understand how their decisions, instructions, documents and other directives can influence the performance and results of work done on the aircraft or its components in workshops, hangars and ramp areas;

3.2.5 Instructors and trainers should ideally have a thorough understanding of the fundamentals of Human Factors as well as knowledge and experience from working in the particular environment (for example, workshops, hangars and ramp areas). They must be able to explain the fundamentals of Human Factors theory and possess theoretical knowledge to a level where they can illustrate with examples as well as facilitate discussions.

3.2.6 Investigators and auditors need to be able to identify, recognize and analyse problems or causal factors related to Human Factors. The investigator must be able to identify contributory Human Factors when investigating incidents. An auditor must be able to recognize potential Human Factors-related risks and report on these risks before they cause an error-related incident and become a subject for the investigator.

3.2.7 AMEs are the last link in the safety chain, and their training objectives are to understand why and how they may inadvertently create an unsafe condition when performing maintenance tasks. It must be possible for them to detect situations where there is the potential for making direct mistakes themselves. They must also be able to detect a built-in error in working instructions or information, and identify faulty equipment. They must understand how the working environment and one's own personal situation affects job performance.

3.3 Training Objectives and Levels

Appendix B lists the training objectives for all categories of maintenance organization personnel. The levels of Human Factors skill, knowledge or attitude should be as follows (where Levels 2 and 3 assume that the objectives of earlier levels have been met):

(1) Level 1: A familiarization with the principal elements of the subject. On completion of the training, a trainee should be able to meet the following objectives:

(a) Be familiar with the basic elements of the subject;

(b) Be able to give a simple description of the whole subject using everyday words and examples; and

(c) Be able to use typical Human Factors terms.

(2) Level 2: A general knowledge of the theoretical and practical aspects of the subject. On completion of the training, a trainee should be able to meet the following objectives:

(a) Understand the theoretical fundamentals of the subject and be able to give a general description of the subject with typical examples;

(b) Read and understand literature describing the subject; and

(c) Be willing and able to apply Human Factors knowledge in a practical manner.

(3) Level 3: A detailed knowledge of the theoretical and practical aspects of the subject. On completion of the training, a trainee should be able to meet the following objectives:

(a) Know and understand the theory of the subject and its interrelationships with other appropriate subjects;

(b) Be able to give detailed explanations of the subject using theoretical fundamentals and specific examples;

(c) Be willing and able to combine and apply subject knowledge in a logical, comprehensive and practical manner; and

(d) Be able to interpret results from various sources and apply corrective action as appropriate.

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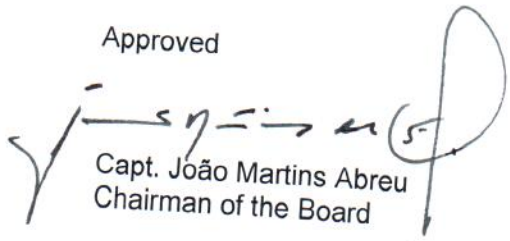
Approved



Capt. João Martins Abreu
Chairman of the Board

APPENDIX A
Guidelines for the development and Amendment of Maintenance Procedures

The following guidelines should be used by air operators and maintenance organizations in the production and amendment of maintenance procedures:

A1. DOCUMENT CONTENTS

(1) Ensure procedure design and changes involve maintenance personnel who have a good working knowledge of the tasks;

(2) Validate all procedures and changes to those procedures before use, where practicable;

(3) Ensure procedures are accurate, appropriate and usable, and that they reflect best practice;

(4) Take into account the level of expertise and experience of the user; where appropriate, provide an abbreviated version of the procedure for use by experienced AMEs;

(5) Take into account the environment in which the procedures are to be used;

(6) Ensure that all key information is included without the procedure being unnecessarily complex;

(7) Where appropriate, explain the reason for the procedure;

(8) Ensure that the order of tasks and steps reflect best practice, with the procedure clearly stating where the order of steps is critical and where the order is optional;

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

(10) Group steps into "chunks" and plan for interruptions. Train staff to complete a "chunk" of steps before allowing themselves to be interrupted, and design the procedure in such a way that it can be marked when and where an interruption occurs;

(11) Ensure consistency in the design of procedures and use of terminology, abbreviations, references, etc.;

(12) 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;

(13) 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;

(14) Avoid cross-referencing 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);

(15) 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;

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

(17) Use emphasis (e.g. italics and bold) consistently. Avoid overuse of upper case for emphasis; lower case is easier to read. Avoid overuse 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;

(18) 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 than 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 and labelled appropriately; and

— the diagram/photograph is clearly linked with a procedure/step;

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

(29) 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);

(30) Distinguish between directive information, reference information, warnings, cautions, notes, procedures and methods;

(31) 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;

(32) Cautions, warnings and notes must be on the same page as the text to which they refer;

(33) Where practical, build in check boxes into the procedure to enable and encourage the user to check off steps as they are completed;

(34) Clearly link the check box with the associated step, e.g. using dotted lines;

(35) Allow enough space if information needs to be entered;

(36) Stress the importance of clear handwriting if written information needs to be handed over to another person;

(37) Ensure that printing/copy quality is good, and that there are enough printers, copiers, etc.; and

(38) Provide training on the use of technology to access and print procedures and maintenance data.

A.2 INFORMATION READABILITY

The following guidelines on information readability should be used:

Typographic layout

Page size

(1) Use a standard paper size (A4).

Page layout

(1) Use a single column layout as this is easier for lower-level readers and does not affect more experienced readers.

(2) For A4 paper format, use a left margin of 2,5 cm to 3 cm and allow at least 2,5 cm for all other margins. The ideal line length is 10 to 12 words, or about 15 cm.

(3) Label each page with a subject heading at the top.

(4) Number each page sequentially placing the numbers at the lower right corner, 1.25 cm above the bottom edge of the page and not extending into the right margin.

(5) There is no need to end every page at the same point, i.e. the baseline can vary from page to page.

Justification

(1) Use left justification, i.e. typing lines up at left edge only. Centre and right justification is distracting and can slow reading speed.

Paragraphs and indentation

(1) Use modified block style with two space indentation for subdivisions.

(2) Label each heading and sub-heading sequentially, i.e. 1., 1.1, 1.1.1, etc.

(3) Within a heading, keep paragraphs below half a page in length, to help the reader's concentration.

(4) Leave one blank line between paragraphs.

(5) Do not indent the start of each paragraph.

Spacing

(1) Use 1:2 space ratio between sentence spacing and paragraph spacing.

(2) Use one blank line to separate all paragraphs and headings.

(3) Use one space after commas, colons and semicolons.

(4) Use two spaces after periods, question marks and exclamation marks.

Typeface (font)

(1) Use the typefaces (fonts) which have a relatively large height, are moderately expanded, solid rather than delicate looking, and have fairly uniform type colour, for example, Times Roman, Century Series, New Gothic, or Helvetica. Times Roman is the most common font style and the least fatiguing to proofreaders due to its easy readability.

(2) Keep the font consistent throughout the document and between documents.

Type size (font size)

(1) Use sizes between 9 and 12 points for ease of reading. The best size for most uses is 11 or 12 points.

Emphasis

(1) Keep a consistent use of emphasis throughout the document and between documents.

(2) To emphasize a single word, use bold (most preferred), underlining, italics or all capitals (least preferred).

(3) To emphasize a lengthy passage, use bold or underlining. Avoid CAPITALS or italics as they slow reading and reduce comprehension.

(4) Use only one or two emphasis techniques within a document to increase comprehension. Bold and underlining are good choices.

(5) Do not overuse emphasis techniques as it causes confusion and reduces comprehension.

Responses

(1) If you are using a check box following the related instruction, do not use a large gap between the check box and the instruction.

(2) Avoid the use of a sign box with “Not Required” or “XXXXX” if the user of the document is not responsible for the instruction accomplishment.

(3) Use a consistent check box design throughout the document if it is possible.

(4) Give enough space if you are expecting any answer from the user.

Colour

(1) Avoid regular use of colour in illustrations. Use distinctive shading patterns within black line images instead of colour.

(2) Coloured paper does not photocopy well.

(3) Black ink on white paper is recommended.

Pagination

(1) Avoid use of any reference back to previous text.

(2) Avoid references to other sections of the document as far as possible. Unavoidable cross references must be precise and unmistakable.

(3) The page should act as a naturally occurring information module, i.e. it should contain an appropriate number of tasks and avoid carryover of task across pages.

(4) Each task that begins on a page should also end on that page.

(5) Minimize the routing; in other words, do not route the user from page to page since it can cause serious defects.

Letters, Numbers and Words

Letters and numbers

(1) Use lower case letters instead of upper case in the text since lower case letters are much easier to read because they have more distinguishable shapes (ascenders and descenders). Note that upper case letters occupy more space (40 to 45 per cent more than lower case letters) and reduce the reading speed by 13 to 20 per cent.

(2) Use mixed-case headings and sub-headings instead of all capitals to improve readability.

(3) Avoid hyphens which merely indicate word division at the end of a line.

(4) In series of words or statements which present mutually exclusive choices, making the “or” explicit throughout the series enhances comprehension.

(5) Avoid using Roman numerals since they are not easy to read and can cause confusion.

(6) Use Arabic numbers followed by a period for each item in your list if you should use numbers. If not, you can use a bullet or dash to get the attention of the user.

(7) Do not enclose the number in parentheses.

(8) Use a conventional (ATA style) dash-number breakdown such as chapter-section-subject-page (e.g. 26-09-01-02).

Words

(1) Avoid using different terms for the same object.

(2) Use precise, unambiguous and common words, with which the user of the document is familiar, throughout the document for consistency.

(3) Do not use many prepositions; they cause the user to read slowly.

Abbreviations

(1) Use only known acronyms and proper nouns.

(2) Avoid abbreviations. If you have to use abbreviations, then:

(a) Use them consistently; and

(b) Use the first few letters to remind the reader of the word.

(3) Provide a glossary if the users need one.

Writing well

General considerations on writing

(1) Try to achieve a balance between brevity, elaboration and redundancy of information.

(2) Complement verbal material by appropriate pictorial representation.

(3) Adapt the format of instruction to the characteristics of the respective task.

(4) Write clear, simple, precise and self-explanatory instructions.

(5) Minimize the writing requirement for the users of the documents.

(6) Summarize the main ideas of lengthy prose passages in a section before the text since it aids in learning the context.

(7) Use adequate information in the instruction steps.

(8) Text should be written in a consistent and standardized syntax.

(9) Text should be as brief and concise as practicable.

(10) Use a logical structure of sentences and paragraphs since they are easier to understand and remember. Logically place:

— General before specific provisions;

— Important before lesser provisions;

— Frequent provisions first; and

— Permanent before temporary provisions.

Sentences

(1) Use simplified language as much as possible.

(2) Use short sentences instead of long ones since short sentences are easier to read and understand.

(3) Use definite and affirmative sentences in the active tense instead of using negative forms and passive tenses since the active voice increases comprehension.

(4) Use sentences with personal pronouns since they increase comprehension and the reader's motivation.

(5) Sentences with many subordinate clauses are difficult to comprehend.

(6) Use action verbs because they are easier to read and understand.

(7) Do not use sentences with a long noun string, since they are hard to understand.

(8) Use sentences complete with the necessary "who" and "which" words to clarify the relative clauses. This should avoid ambiguity and ease reading.

(9) Use third person for definitions as follows:

"The torsion link assembly transmits torsional loads from the axle to the shock strut."

(10) Use second person imperative only for operational procedures as follows:

"Check the oil level."

(11) Ideas expressed in positive terms are easier to understand.

(12) State directly what you want to say without excess or unnecessary words since the sentences with unnecessary words are harder to understand and take longer to read.

Lists and tables

(1) Data and information presented in the tables facilitate understanding and comparison.

(2) In lists and tables, do not leave blanks within a line greater than 1,25 cm or five spaces.

(3) Group the lines in lists and tables according to content.

(4) Do not group more than five lines together.

(5) Separate the groups in the list and table by spacing.

(6) Write the list of items in parallel construction since that way is easier to read and remember.

(7) List a series of items, conditions, etc. rather than displaying them in a series separated by commas.

(8) Avoid using compound questions and statements.

(9) Minimize the logically related question as much as possible.

(10) Construct the questions in a way which requires minimum memory use from the user of the document.

Graphic information

(1) Place the visual item in the text of a document near the discussion to which it relates. If it is not possible, place the visual item in an appendix, label the item and refer to it.

(2) Use a clear title with a figure or a table number on the line directly below all illustrations.

(3) Use the same title for illustrations as corresponding text subject title.

(4) Use either a horizontal-landscape format with the top of the illustration at the binding edge or vertical layout to present graphic information for ease of reading and cross-reference consistently.

(5) Adequate text must be supplied to support illustrations, not vice versa.

(6) Draw illustrations in a size and line weight such that they can be used without any rework for the production of material for screen projection in a training environment.

(7) Illustrations should have limited information in order to avoid a cluttered appearance. The presentation should be self-explanatory.

(8) Use illustrations as the primary source of information transfer.

(9) Present all spatial information in graphical format instead of in textual format.

(10) Label each table and figure with an Arabic numeral, such as Table 1 and Figure 1.

(11) Use simple line drawings, which are superior in most cases.

(12) Use a consistent format for figure layout and numbering.

(13) Use illustrations whenever they will simplify, shorten or make the text easier to understand.

(14) Do not use complicated reference numbers for figures, e.g. T07-40423-001.

(15) Avoid use of perspective part drawings as figures.

(16) The figure views should be as the user sees it.

(17) Use standard and correct technical drawing terminology, e.g. avoid use of terms “section” and “view” interchangeably.

(18) Reference all tables and figures in the text by the numbers.

(19) Use bar charts to make accurate comparison of numerical data whenever possible.

(20) Line charts (or graphs) help to understand trends and allow accurate comparison between two or more numerical values.

Printing and copying quality

(1) Check the toner box regularly to have consistent copy quality.

(2) Make sure that no major image degradation occurs with reproductions of originals.

(3) Use paper which has a reflectance of at least 70 per cent.

(4) Use low visual acuity and large type size if user is going to use the document under low illumination levels.

(5) Readers prefer matt paper to medium or glossy paper.

(6) High opacity paper is preferable.

(7) Use black ink on white paper since it is more effective than white ink on black paper.

(8) Develop and implement standards for changing printer ribbons, toner boxes, etc. to ensure a consistent print quality at all times.

A.3 ORGANIZATIONAL ISSUES

(1) Allow the prospective users of work cards to participate in the design of the document.

(2) Check every individual instruction by testing it in the field situation.

(3) If your document is going to include multiple copies, colour can be a useful processing aid.

(4) Have a feedback system so that users are aware of how to correct an erroneous entry.

APPENDIX B – HUMAN FACTORS TRAINING SYLLABUS OBJECTIVES

Note.— The training syllabus objectives are listed under ten topic headings. Each topic is identified as follows:

— (S) = Skill;

— (K) = Knowledge; and

— (A) = Attitude.

1. General introduction to Human Factors:
   - Achieve a basic understanding of the meaning of the term “Human Factors” (K).
   - Recognize the contribution of Human Factors to aircraft accidents (K).
   - Understand the goal of Human Factors training (K).
   - Appreciate the need to understand and address Human Factors (A).
   - 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 (K).
2. Safety culture and organizational factors:
   - Achieve a good understanding of the concept of “safety culture” (K).
   - Understand the meaning of “organizational aspects of Human Factors” (K).
   - Appreciate the importance of a good safety culture (A).
   - Identify the elements of a good safety culture (K).
3. Human error:
   - Appreciate that human error cannot be totally eliminated; it must be controlled (K).
   - Understand the different types of errors and their implications, and avoiding and managing error (K).
   - Recognize where the individual is most prone to error (K).
   - Have an attitude likely to guard against error (A).
   - Achieve a reasonable practical knowledge of the main error models and theories (K).
   - Understand the main error types and how they differ from violations (K).
   - Understand the different types and causes of violations (K).
   - Avoid violating procedures and rules and strive towards eliminating situations which may provoke violations (A).
   - Achieve a good understanding of well-known incidents in terms of errors leading towards the incidents (K).
   - Appreciate that it is not errors themselves that are the problem but the consequences of the errors if undetected or uncorrected (A).
   - Understand the different ways of reducing errors and mitigating their consequences (K).
   - Have a basic understanding of the main Human Factors concepts and how these relate to risk assessment. *Note: This has management applicability* (K).
4. Human performance:
   - Recognize the effect of physical limitations and environmental factors on human performance (K).
   - Appreciate that humans are fallible (A).
   - Achieve basic knowledge of when and where humans are vulnerable to error (K).
   - Recognize where self or others suffer and ensure this does not jeopardize aviation safety (A).
   - Understand how vision and visual limitations affect the trainee’s job (K).
   - Recognize the need to have adequate (corrected) vision for the task and circumstances (K).
   - Be aware of the health and safety best practice regarding noise and hearing (K).
   - Appreciate that hearing is not necessarily understanding (A).
   - Obtain a basic familiarity with the key terms used to describe information processing (i.e. perception, attention and memory) (K).
   - Achieve a basic understanding of the meaning of attention and perception (K).
   - Understand the dimension of situational awareness (K).
   - Develop ways of improving situational awareness (S).

- Achieve a basic understanding of the different types of memory (sensory, short-term, working, long-term) and how these may affect the person at work (K).
- Appreciate that memory is fallible and should not be relied upon (A).
- Appreciate that claustrophobia, fear of heights, etc. may affect the performance of some individuals (A).
- Understand what motivates and demotivates people in maintenance (K).
- Appreciate the need to avoid misdirected motivation (cutting corners) (A).
- Develop a willingness to admit when feeling unwell/unfit and take steps to ensure this does not affect the standard of work performed (A).
- Recognize the basic concepts and symptoms of stress (K).
- Develop different techniques and positive attitudes to cope with stress (S).
- Recognize the need to manage workload (K).
- Develop methods to manage workload (S).
- Understand how fatigue can affect performance especially with long hours or shift work (K).
- Develop ways of managing fatigue (S).
- Develop a personal integrity not to work on safety critical tasks when unduly fatigued (A).
- Appreciate that alcohol, drugs and medication can affect performance (A).
- Understand the effects of sustained physical work on overall performance, especially cognitive performance in maintenance (K).
- Be aware of examples of incidents where repetitive tasks and complacency were a factor (K).
- Develop ways of avoiding complacency (S).

5. Environment:
   - Achieve a basic appreciation of how the physical and social environment can affect human performance (K).
   - Appreciate the importance of sticking to the “rules” even if others do not (A).
   - Appreciate the importance of personal integrity (A).
   - Appreciate the importance of avoiding placing peer pressure on others (A).
   - Develop assertive behaviour appropriate to the job (S).
   - Achieve a basic understanding of the concepts of stress and stressors as related to the maintenance environment (K).
   - Recognize the dangers of cutting corners (K).
   - Recognize the dangers of applying inappropriate deadlines (K).
   - Recognize the dangers of self-imposed supervisor and manager time pressures (K).
   - Understand the basic contributors to workload (K).
   - Develop planning and organizing skills (S).
   - Understand the basic concept of circadian rhythms as this relates to shift work (K).
   - Be familiar with best practice regarding working hours and shift patterns (K).
   - Develop strategies to manage shift work (S).
   - Be aware of the health and safety guidance concerning noise and fumes (K).
   - Be aware of the effects of lighting on performance (K).
   - Be aware of the effects of climate and temperature on performance (K).
   - Be aware of the health and safety guidance concerning motion and vibration (K).
   - Be aware of the implications of own actions on other parts of the maintenance system (K).
   - Be aware of the health and safety guidance concerning hazards in the workplace (K).
   - Understand how to take into consideration the available manpower when scheduling, planning or performing a task (K).
   - Develop ways of managing distractions and interruptions (S).
6. Procedures, information, tools and practices:
   - Appreciate the importance of having available the appropriate tools and procedures (A).
   - Appreciate the importance of using the appropriate tools and following the procedures (A).

- Appreciate the importance of checking work before signing it off (A).
- Appreciate the importance of reporting irregularities in procedures or documentation (A).
- Understand the factors that affect visual inspections (K).
- Develop skills to improve visual inspections (S).
- Appreciate the importance of correct logging and recording of work (A).
- Be aware that norms exist and that it can be dangerous to follow them (A).
- Be aware of instances where the procedures, practices or norms have been wrong (K).
- Appreciate the importance of having a good standard of technical documentation in terms of accessibility and quality (A).
- Learn how to write good procedures reflecting best practice (S).
- Learn how to validate procedures (S).

7. Communication:
   - Recognize the need for effective communication at all levels and in all mediums (K).
   - Understand the basic principles of communication (K).
   - Develop skills, and correct verbal and written communication appropriate to the job and the context within which it is to be performed (S).
   - Have detailed knowledge of some incidents where poor handover has been a contributory factor (K).
   - Appreciate the importance of good handover (A).
   - Learn how to carry out a good handover (S).
   - Appreciate the importance of information being kept up to date and being accessible by those who need to use it (A).
   - Appreciate that cultural differences can affect communication (A).
8. Teamwork:
   - Understand the general principles of teamwork (K).
   - Accept the benefits of teamwork (A).
   - Develop skills for effective teamwork (S).
   - Believe that maintenance personnel, flight crew, cabin crew, operations personnel, planners, etc. should work together as effectively as possible (A).
   - Encourage a team concept, but without devolving or degrading individual responsibility (A).
   - Understand the role of managers, supervisors and leaders in teamwork (K).
   - Develop team management skills for appropriate personnel (S).
   - Develop decision-making skills based on good situational awareness and consultation where appropriate (S).
9. Professionalism and integrity:
   - Understand what is expected from individuals in terms of professionalism, integrity and personal responsibility (K).
   - Understand the person's responsibility to keep standards high and to put this into practice at all times (A).
   - Accept the personal responsibility to keep up to date with necessary knowledge and information (A).
   - Achieve a good understanding of what is error-provoking behaviour (K).
   - Appreciate the importance of avoiding the type of behaviour which is likely to provoke errors (A).
   - Appreciate the importance of being assertive (A).
10. The maintenance organization's own Human Factors programme:
    - Achieve an in-depth understanding of the structure and aims of the company's own Human Factors programme, for example:
      — The Maintenance Error System (K).
      — Links to the Quality and Safety Management Systems (K).
      — Disciplinary reporting and a just culture (K).
      — Top-level management support (K).
      — Human Factors training for all maintenance organization staff (K).
      — Actions to address problems (K).

— Good safety culture (K).

- Appreciate the importance of reporting incidents, errors and problems (A).
- Understand what types of problems should be reported (K).
- Understand the mechanisms of reporting (K).
- Understand the organization's policy and the circumstances under which disciplinary action may be appropriate and when not appropriate (K).
- Appreciate that the person will not be unfairly penalized for reporting or assisting with disciplinary investigations (A).
- Understand the mechanisms of incident investigation (K).
- Understand the mechanisms of actions to address errors (K).
- Understand the mechanisms of feedback (K).

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