GUIDELINES OF SAFETY SYSTEM
AND HUMAN FACTORS APPROACH
FOR PART 145 MAINTENANCE ORGANISATIONS
The object of the revision 1 is the integration of the acceptance criteria of the HF external instructors.
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1. OBJECT

The hereby fascicle is an implementation guide aimed at Maintenance Organisations on the requirements related to Safety notion and Human Factors mentioned in Appendix II (Part 145) of the (EC) regulations n°2042/2003.

It is meant to lay out the key items to be known on these issues and to give some recommendations for the practical enforcement of the new Part 145 requirements in organisations.

2. SCOPE

This fascicle applies to all approved maintenance organisations or to those applying for a Part 145 approval to carry out maintenance tasks on aircraft, engines and aircraft equipment.

It was written to deal basically with the case of organisation maintaining heavy aircraft (A rating). It can however be easily be adapted to organisation maintaining non-heavy aircraft, engines or equipment.

It should be regarded neither as an exhaustive nor as a limitative document. The principles described herein must be adapted to each organisation according to its size, scope, technological level, and own company culture.

3. REFERENCES

3.1 European documents


3.2 GSAC Fascicles

- R-40-10 Issue 1 revision 0
- P-54-15 Issue 1 revision 0
  AMC PART 145.
- P-54-18 Issue 1 revision 0
  Guidelines of PART 145 MOE
- P-54-26 Issue 1 revision 0
  Guidelines of PART 145 MOE for foreign maintenance organisations
3.3 Systems of reference regarding human factors

- CAP 716 Aviation Maintenance Human Factors (www.caa.co.uk)

4. DEFINITIONS

Human Factors principles: principles associated to the aeronautical activities of design, certification, training, operation and maintenance and aiming to ensure the safety of the interface between man and all the other items of the system, taking human performance into account.

Human performance: human performance and limitations that may affect the safety and efficiency of the maintenance tasks to be performed.

Authority : When this term is used the authority is the French DGAC / GSAC
HF : Stands for « Human Factors »
MO : Stands for « Maintenance Organisation »
MOE : Stands for « Maintenance Organisation Exposition »

5. PRESENTATION OF THE GUIDE

The guide shown in Appendix I of this fascicle was built up according to the requirements of the Part 145 regulations (145.A.25 through 145.A.65).

Most of the pieces of information it includes come from the three main documents listed in paragraph 3 regarding safety and human factors.

It makes a synthesis of these documents that have a joint approach of the issue dealt with.

This document is a consciousness-raising and general information tool on the Safety/Human Factors issues. It also helps for the practical enforcement of the main principles associated to human factors/safety required by the Part 145 regulation.

It goes without saying that a person or group of persons in charge of the implementation of the safety policy and the human factors approach within a company cannot be satisfied only with these pieces of information. It will be useful to refer to these documents and to the studies referenced in them.

A suggestion of implementation plan of these measures is presented in Appendix II.

Appendix III includes a glossary of error notions and a diagram enabling to analyse the errors.

APPENDIX 1

GUIDELINES OF SAFETY NOTION AND HUMAN FACTORS RELATED MEASURES
0. INTRODUCTION

The first Human Factors approach in aeronautical companies was made at the level of flight crew members. International statistics underscored the high flight crew contribution to the causes of accidents. If the major international operators began introducing these notions as soon as in the late eighties, the regulatory requirement to enforce Human Factors related principles for flight crew was first introduced in France in 1997 in the order of 1987 related to the conditions of use of aircraft, then in the OPS 1 order that had been mentioning since 1999 general Crew Resource Management related concepts.

Regarding maintenance activities, if some Human Factors notions were continuously added in JAR145 regulations (e.g. working conditions, human factors continuous training for certifying staff) and in JAR66 regulation (e.g. human factors assessment – module 9), the introduction of safety and human factors notions generally and systematically in aeronautical maintenance activity becomes a reality with the new Part 145 regulation issued on November 28th, 2003.

These notions are linked to a very important evolution of the aeronautical maintenance sector.

The maintenance organisations are required to dedicate the necessary means and resources to acquire enough knowledge on the issue and implement these new principles efficiently and in a voluntarist way in the entire organisation.

The human performance and environment related information is given in this guide as an indication.
It stands for indicative values without taking into account possible specific conditions and in no case replaces any current regulation on these matters (labour, health, environment laws, labour agreements, orders of the prefect).

In any case, the hierarchy of social standards must be respected.
The recommendations of the hereby guide therefore do not exempt employers from following the rules set by labour laws and agreements.
1. **HUMAN FACTORS IN INCIDENTS AND ACCIDENTS**

Several studies on incidents and accidents, as well as on their causes and the contributory factors associated to these occurrences were carried out these last years by different aeronautical actors (Boeing, NTSB, UK CAA..).

These elements show that as a whole 70 to 80% of accidents and incidents are related to human factors.

On the period from 1970 to 2000 (ICAO study), bearing in mind that several factors can play a part as far as an accident is concerned, the factor related to pilot actions involved 60% of the accidents and the factors related to maintenance involved 10% of the accidents.

A recent study (BOEING) on main accident factors showed that between the periods 1959 -1989 and 1990-1999, the main factor associated to pilot actions lowered significantly (from 74% till 67%) whilst the main factor related to maintenance increased during that period (from 2.5% till 5.9%).

Another study carried out in 2001 (CAA UK) showed a high and continuous increase in the number of maintenance errors during the 1990-2000 period.

As a whole, the accident rate lowered along these years to reach 1.5 accidents out of 1 million departures but we witness a certain stability of this rate without any sign of diminution for the moment.

If this rate enables to state that civil aviation is amongst one of the safest means of transportation, a significant increase in the number of accidents can be expected because of the anticipated traffic increase during the coming years. With 5% of yearly increase, without any fundamental improvement related to contributory factors, the number of major accidents per year could increase significantly to reach one airliner accident a week in the coming years (2010-2015) with all the consequences easy to imagine.

The major aim in the coming years is therefore to lower this overall accident rate.

In the specific case of maintenance, regarding maintenance activity, the introduction in the Part 145 regulation of Safety (priority objective) and Human Factors notions (new principle helping in reaching goals) has for main aim to arise consciousness and to motivate all the actors involved in this Safety issue, to improve the safety of maintenance activities trying to lower the errors or risks of errors in the frame of maintenance.

*Several major accidents and incidents, for which human factors were identified as the significant cause of these occurrences are described in Appendix A Chapter 1 of the ICAO report doc 9824 and Appendix D of the CAP 716 guide.*
2. GENERAL POINTS ON MAINTENANCE ERRORS AND CONTRIBUTORY FACTORS

Maintenance errors contribute highly to commercial aircraft accidents and incidents and cause important additional costs. Scarce research and analysis were performed on their causes till recently.

If human beings are the more flexible, the more adaptable, the greatest value of the aeronautical system, they are also vulnerable and some conditions can reduce their performances.

As most of the accidents and incidents result of a poor adaptation of the limits of human performance to the conditions of fulfilment of the assigned tasks, the trend is often to attribute their causes to «human errors». This last term is not very useful for the prevention of accidents and incidents, even if it shows where the system failed, it does not help in determining the causes of the failures of protective schemes (or barriers).

The understanding of human factors in aviation was progressively refined and developed to include maintenance activities after a first profitable approach of the issue with flight crew members. Today, the data accumulated in the subject enable the operators and maintenance organisations to define and implement policies aiming at reducing the risks of maintenance errors.

As a whole, any person, even a very skilled one, can make unwittingly errors (refer to the saying: «to error is human»). Error is even full part of the evolution and learning process of the organisation and of each individual.

By lack of general or specific training, by lack of experience, because of ill-adapted means, of deteriorated environmental conditions, of some physical/psychological specificities and all the other reasons developed in this guide, individuals can fulfil their assignments inadequately.

Regarding maintenance, some studies isolated 3 types of errors among the most frequent ones, that is:
- Forgetting to reset a system, installing or removing an interlock, tightening properly a fastener, removing some tooling, forgetting to install a given element (pins, nuts..),
- The incorrect installation of a component,
- The installation of a part not adapted to the aircraft.

Contributory factors that are most often met in the frame of these human errors, not classified by order of importance, are as follows:
- Too high pressure / important stress level,
- Insufficient communication,
- Language difficulties (reading, draft, communication in English…),
- Incorrect or ambiguous maintenance procedures or data,
- Skill inadequacy compared to the works to be carried out,
- Problems of instruction handover during shift changes, problems related to the interruption of works (distraction, changing a person to a more priority task),
- Fatigue,
- Dysfunctions in teamwork, supervision, coordination,
- Routine, boredom,
- Lack of self-assurance or conversely excess of self-confidence,
- Lack of watchfulness, unawareness of consequences,
- Non availability of means (maintenance data, materials, tooling..),
- Insufficient environmental conditions (e.g. lighting).

In most cases, the accident or incident is the consequence of several errors or dysfunctions at different levels of the organisation (training, planning, management, team…) that cumulate and add up at the same time.

When analysing some incidents, an accumulation of errors related to the launching, fulfilment of an operation, control of this operation, record of the works and tests after completion of the work can often be noted…

This principle is described in the example below.

These findings justified the decision to introduce this notion of Human Factors in the maintenance activity to try and lower the overall rate of accidents.

Further and more detailed information can be obtained on these issues by reading chapter 2 and appendix B to chapter 2 of the ICAO report doc 9824 and chapter 3 and appendix D of the CAP 716 guide.
3. SYNTHESIS OF PART 145 REGULATION REQUIREMENTS REGARDING SAFETY AND HUMAN FACTORS

Taking into account the aforementioned elements, several new requirements were therefore embodied in Part 145 on the notion of Safety and Human factors.

The organisations are required by Part 145 regulations to implement a Safety policy and practical measures (procedures, means, systems…) associated to Human Factors (instructions handover, reporting errors in the documentation, error capture system, signing off tasks/sub-tasks, training of the whole staff of the organisation in human factors, implementation of an internal reporting and analysis of maintenance errors system).

The table below specifies the main requirements involved in Part 145.

Some Human factors related elements have already been introduced in the latest versions of JAR145 (working conditions, Human Factors training for certifying staff…).

The main new elements introduced in Part 145 have an asterisk in the table below.

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4. **INTRODUCTION OF THE NOTION OF « MAINTENANCE SAFETY SYSTEM »**

The introduction in the nineties of the notion of Quality System in JAR145 regulations enabled the maintenance organisations to standardize their processes and to have supervision systems enabling to detect and rectify some operational dysfunctions likely to appear in their company. These Quality Systems enabled to formalise the main working rules (maintenance procedures) and to improve in most cases the operation of these companies.

As mentioned in the Human Factors document ICAO doc 9824, when asking maintenance organisations senior staff: « How do you know that your organisation carries out quality services meeting safety requirements? », the answer is too often just a statement that they enforce regulatory requirements…

If basically, the organisations must meet the regulatory requirements, just wanting to « stick to the minimal requirements of regulations » is not enough in an approach centred on safety.

Regulations must be regarded as a set of basic rules and objectives that each organisation must enrich with their own requirements and rules adapted to their organisation (size, products, deviance situation…).

If Quality systems are mainly oriented on checking the compliance of the organisations with their procedures / internal rules based on the current regulations, they must be completed by systems and means specifically dedicated to all the safety related aspects (incidents, errors, hazards..).

Part 145.A.65 (a) requires the Maintenance Organisations to define and implement a Safety policy in addition to the Quality policy.

If Part 145 is limited to Safety Policy, it can be more generally interesting to globalise this new notion of Safety in each organisation and possibly to introduce a « Maintenance Safety System » (notion similar to that of OPS Flight Safety System) that could include the items below:

- Safety Policy,
- Safety culture within the company,
- Responsibilities and functions of the Maintenance Safety System in the organisation.
4.1 Safety Policy

According to Part 145.A.65 (a), a safety policy must be instituted within the company. This policy must define in a detailed manner how the organisation endeavours to turn Safety into a priority objective.

This policy should be published and issued to all the personnel of the company as well as to the non-approved subcontractors working under the Quality system of the approved company. This policy formalises the Safety commitment of the Management of the company.

This policy must in any cases be described in chapter 1.2 of the MOE.

The key points that can be dealt with in a Safety policy are as follows:

- Acknowledge Safety as a constant preoccupation for all the personnel,
- Have a strict organisation always trying to improve itself,
- Make sure that the safety standards are not eroded by commercial drivers,
- Make sure to use properly the resources and to carry out maintenance right first time,
- Enforce the principle associated to « human factors »,
- Commitment to implement initial and continuous training associated to human factors,
- Encourage the personnel to report any maintenance error,
- Implement a suitable working environment to attract and keep skilled and motivated personnel,
- Provide staff with appropriate tools, materials, instructions and time to perform maintenance in accordance with the procedures,
- Acknowledge that the enforcement of the procedures, quality standards, safety standards and regulations must involve all the personnel of the organisation,
- Acknowledge the need for the personnel to cooperate with the organisation's quality auditors.

4.2 Safety Culture

An organisation with a good company safety related culture is one that succeeds in institutionalising safety as a basic value of the organisation in which personnel at any level of the organisation share the same concerns towards safety.

It could be interesting before the implementation or afterwards to assess the company culture in terms of level of implication in safety issues. Questionnaires can be developed to do so. See detailed questionnaires in appendix M of the CAP 716 guide.

4.3 Responsibilities / functions of the Maintenance Safety System

One of the key items associated to this approach is the unrestricted commitment towards safety by the organisation's management and before all by the Accountable Manager.

The Accountable Manager must ensure that the Safety related responsibilities are defined in the structure of the company and assigned to one or more senior persons, skilled in the issue and both with the required legitimacy and means.

In any case, it is important that all the management personnel involve themselves unrestrictedly towards safety in practice on the field, through actual facts and not only verbally or only when safety related actions do not involve any cost.
As already specified, if the Part 145 regulation does not mention any Maintenance Safety System as such, it is advised to introduce this notion of Safety policy and to keep it lively leaning on a nominated responsible person and a dedicated system.

A Maintenance Safety responsible person could therefore be nominated for that and could report, like the Quality manager, to the Accountable Manager. In some cases, the quality manager could also take in charge this safety responsibility provided he/she has some means and skills dedicated to the Safety activity under his/her responsibility and independent from the structure Quality audits.

Safety coordinators can also be nominated in each sector of the organisation in order to deal on the field with safety related issues.

The main functions that can be affected to this Maintenance Safety System are for instance:

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<td>Analysis of risks,</td>
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<td>Coordination / follow up of the Human Factors approach,</td>
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<td>Safety information feedback to the Accountable Manager,</td>
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<td>Promotion of Safety within the organisation.</td>
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4.4 Maintenance Safety System Related Procedures

The procedures associated to the analysis/investigation related to incidents/maintenance errors can be developed and presented in the MOE.

Further more detailed information can be obtained on these issues by reading chapter 2 of the ICAO report doc 9824 and chapter 2 and appendices E, F and G and M of the CAP 716 guide.

5. HUMAN FACTORS CONCEPTS

One of the principles associated to the Safety policy is taking Human Factors into account in the organisations.

As we have already seen, anyone can be led to make unintentionally more or less serious errors in their professional activity.

The term « human errors » can lead to confusions in the frame of incident or accident analysis because it only enables to determine the level at which the system did not work properly and not the causes of this dysfunction.

Isolating a human error in the frame of such analyses is a first stage. But just answering that there is a human error should not be regarded as an acceptable answer.

The knowledge of human limitations and performance already enables to become aware of everyone's limitations and to take the preventive necessary steps. It also enables to determine the factors that contributed to observed human errors and take the necessary corrective actions.

By definition, are called Human Factors, all the factors related to the environment, organisation and work, as well as human and individual characteristics, which have an influence on the behaviour at work and may affect health and safety.

It is only by an approach taking into account human factors that « man can be adapted to his job and the job to the man ».
Human factors deal with the relations between the **INDIVIDUAL** and:

**DATA** (procedures, maintenance data, wokcard, computer systems…),

**MATERIALS** (tooling, equipment .),

**ENVIRONMENT** (lighting, working space, noise, temperature…)

and the other **INDIVIDUALS** (communication, coordination, workloads..)

Taking Human Factors into account has an influence on the efficiency of the systems, activities and companies, including safety and the proper operation as well as the well being of the individuals themselves in the frame of their works.

*Further more detailed information can be obtained on these issues by reading chapter 1 of the ICAO report doc 9824 and chapter 2 and appendix B of the CAP 716 guide.*
6. **HUMAN FACTORS APPROACH**

6.1 Elements of the Human Factors approach

The Human Factors approach must be oriented on:

1. **the improvement of the relations INDIVIDUAL – ENVIRONMENT**
   Taking human factors into account within the working environment (145.A.25).

2. **the improvement of the relations INDIVIDUAL – MATERIAL**
   Taking human factors into account in the management, supply and use of tooling / access means (145.A.40).

3. **the improvement of the relations INDIVIDUAL - DATA**
   A system enabling to write out internal procedures and instructions taking the human factors related principles into account (145.A.65) and a system to report the errors or ambiguities noted in internal maintenance procedures and instructions (145.A.65).
   A system to report the errors or ambiguities noted on maintenance data (145.A.45).

4. **the improvement of the relations INDIVIDUAL – INDIVIDUAL**
   A training on human factors for all the personnel (145.A.30) so that everyone knows their own and the other’s limits.
   Taking into account the planning/preparation, coordination and teamwork (145.A.47).
   Taking into account the aspects associated to the communication/transmission of instructions and signing off tasks (145.A.47 and 145.A.65).
   Taking into account the factors related to the human performance and limitations in the management of individuals (147.A.47).

5. **the improvement of the systems of error prevention, detection and analysis**
   The systems of error prevention (critical systems) and error capture (functional test, double check) (145.A.65).
   A system of internal reporting, investigation and analysis of maintenance errors or current or potential risks (145.A.60).
6.2 Conditions of Implementation of the Human Factors Approach

The key conditions for the success of the implementation of a Human Factors approach are as follows:
- A formal and real commitment of the management to enforce human factors in the organisation,
- A clear policy of encouragement of the reporting of safety related maintenance errors,
- Audits centred on ergonomics at work and human factors,
- Means and intention to act against internal reported findings as well as those noted during audits and to correct them when necessary,
- A means to inform quickly the persons involved of the actions undertaken following the deviations / errors noted and reported.
- And eventually, a motivation of all the personnel to support these human factors related measures.

6.3 Organisation Related to the Human Factors Approach

The Human Factors approach will be more efficient if it is incorporated in the whole process of the organisation and not dealt with as something additional or limited at short term.

Indeed, like other general knowledge (Communication, Management, Organisation of work…) that can be introduced in the companies, Human Factors at term should become part of the personnel and management team's general knowledge.

Arising sensibility to Human Factors should at term be limited to the initial training of the recently hired people and to the continuous training of the personnel.

On another hand, the implementation of the Human Factors approach will be without any effect if the measures are taken in a marginalized way or regarded by the whole of the organisation as a « fashion ».

If the Maintenance Safety System is implemented, it is recommended to associate it to the Human factors related coordination functions because this system is meant to continue to exist as such later on (analysis of incidents / errors functions).

On the other hand, it can be anticipated, taking into account the workloads for the implementation of the approach Human factors and the complexity of the issues, to appoint a Human Factors specialist (a referent)

Part 145.A.25 mentions some requirements related to the facilities, working conditions and equipment required. Especially, Part 145.A.25 (c) specifies that the working conditions are appropriate for the task carried out and in particular special requirements observed. Unless otherwise dictated by the particular task environment, the working environment must be such that the effectiveness of personnel is not impaired.

The working environment can have direct consequences on the effectiveness of a task and can be an error contributory factor.

<table>
<thead>
<tr>
<th>Hangars</th>
<th>They must be available for base maintenance. Optional for line maintenance, they must however be available when required by some conditions. Hangars must be large enough to perform all the scheduled maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protections against all air contaminations</td>
<td>Contaminations must be minimised to enable an acceptable level of visibility</td>
</tr>
<tr>
<td>Temperatures</td>
<td>Temperatures must be adequate not to generate personnel discomfort</td>
</tr>
<tr>
<td>Lighting</td>
<td>Lighting must be adequate to ensure that each inspection and maintenance task can be properly carried out</td>
</tr>
<tr>
<td>Noise</td>
<td>Noise level must be below personnel distraction level. In the other cases, individual systems of protection against noise must be available and used</td>
</tr>
</tbody>
</table>

Audits centred on environment / ergonomic aspects are recommended. These audits can be internally developed. See a type of audit in chapter 3 and its appendix E of the ICAO report doc 9824 and appendix Q of the CAP 716 Guide.

7.1 **Temperature**

As specified in Part 145.A.25 (c)(1), temperatures must be maintained such that the personnel can carry out required tasks without undue discomfort.

Individuals must work in acceptable conditions of temperature, climate because too high or too low temperatures can have indirect effects on their performance (less dexterity in cold conditions, less concentration…) or indirect ones (being too cold or too hot may lead a technician to accelerate the performance of a work in order to regain better conditions).

Combining means such as hangars, working spaces, temperature regulating systems, clothes and associated procedures can enable individuals to work in proper conditions.
As specified in Part 145.A.25(c), working environment for line maintenance is such that the particular inspection or maintenance task can be carried out without undue distraction. Therefore where the working environment deteriorates to an unacceptable level in respect of temperature, moisture, hail, ice, snow, wind, light, dust/other airborne contamination, the particular inspection or maintenance tasks must be suspended until satisfactory conditions are re-established.

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| Studies confirm that temperate temperatures (from 18°C till 24°C) are optimal. Out of this range, clothes used by the personnel should be adapted. |
| It is proved that at a temperature of about 10°C, manual dexterity is reduced of 50%. |
| In the same way, more special precautions should be taken in the case of scorching temperatures (beyond 30°C). |

For works carried out beyond or below acceptable ambient temperatures, it is important to anticipate enough rest moments in places with satisfactory temperature levels for the personnel during shift work.

7.2 Noise

As specified in Part 145.A.25(c)(4), noise shall not distract personnel from carrying out their inspection tasks. Where it is impractical to control the noise source, such personnel are provided with the necessary personal equipment to stop excessive noise causing distraction during inspection tasks.

Noise should be regarded as an undesirable sound.
In the frame of the maintenance environment, sound is often necessary to carry out a maintenance task. The sounds involved include oral communication between the persons, communications via systems meant for that (talkie, telephone, public address…), audio signals of the test/tooling benches, sounds emitted by aeroplane systems in the case of tests.

On another hand, noise is a factor that can affect human performance in terms of lowering the hearing performance of individuals, interfering in oral communications, diminishing concentration and fatigue. Noise can also affect motivation and lower the tolerance levels of individuals.

For information only

| It is acknowledged that, if a continuous noise is a fatigue factor even below 65 dBA, the continuous level of acceptable maximum noise must generally be found between 70 and 75 dBA. |
| A noise level overtaking these values can exceptionally be accepted with some precautions. |

If one of the means to reduce noise is to provide the personnel with individual protections against noise (helmets, ear plugs…), noise origins must also be reduced if possible by delocalising them (e.g. by putting compressors outside), by isolating the noise against individuals (e.g. isolation box), by noise refaction / absorption systems (acoustic panels…).
7.3 Lighting

Part 145.A.25(c) (3) requires that the lighting is such as to ensure each inspection and maintenance task can be carried out in an effective manner.

Visual inspections stand for about 90% of inspection tasks. That is why, these tasks must be carried out in satisfactory environmental conditions. Studies on the matter showed that insufficient lighting had important consequences on visual fatigue.

If the intensity of lightings is an important issue, the type of lighting and glare sources are also to be taken into account.

The studies carried out on the required lighting intensity enable to specify the following points:

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- The general intensity in facilities should be at least of 750 Lux and preferably of 1000 to 1500 Lux. Regarding visual inspections, a luminosity of 1000 Lux is recommended.
- For detailed inspections and interventions requiring precision, a luminosity of 2000 to 5000 Lux is required.
- Glare sources should be controlled.
- To finish with, the quality of lighting should be adapted using if need be supplemental lighting.

7.4 Reporting of defects noted in environment

Part 145 recommends the implementation of different reporting systems in order to feedback all the observations associated to inadequate maintenance data and procedures and to all the occurrences associated to errors of execution of tasks. Even if Part 145 does not specify it precisely, it sounds logical to anticipate an information feedback system enabling the personnel themselves to report the findings made on environment related issues (organisation, working space, noise..).

The organisations must therefore implement a specific reporting system of environment related problems or to use the error / incident reporting system required in Part 145.A.60.

The advantage of the first solution is to have a sole and single error reporting procedure in the organisation (errors/occurrences, unsuitable procedures, unsuitable maintenance data, unsuitable environment…). It is however advised to make a difference between these two reporting systems in order to manage the priorities, to address directly these environment related reports to the service in charge of their maintenance without using an intermediary service (e.g. Safety System).

This procedure can be described in the MOE Chapter 2.27 (if the title of this chapter is generalised to the « reporting procedure by the personnel of data, procedures, infrastructures, tooling inadequacies…»).

Further more detailed information can be obtained on these issues by reading chapter 3 and appendices E and F of chapter 3 of the ICAO report doc 9824 and chapter 5 and appendices Q and R of the CAP 716 guide.
8. **HUMAN FACTORS TRAINING OF ALL THE PERSONNEL (145.A.30)**

According to Part 145.A.30 (e), the organisation shall establish and control the competence of personnel involved in any maintenance, management and/or quality audit in accordance with a procedure and to a standard agreed by the competent authority. In addition to the necessary expertise related to the job function, competence must include an understanding of the application of human factors and human performance issues appropriate to that persons' function in the organisation.

It is obvious, referring to some accidents and incidents, that human errors and human factors related problems are not limited to technicians but also involve other personnel of maintenance organisations (engineering, planning…). Management staff is also directly involved and may be a contributory factor to a serious occurrence (pressure on personnel, lack of personnel…).

The main objective of human factors training is to give all the persons working directly or indirectly in maintenance, an understanding on the origin of errors and knowledge that these errors can be avoided in the frame of maintenance.

Anyone being liable to make errors, this training must enable all the personnel to identify and avoid the situations that might generate errors. As a whole, this training should show the important place taken by Human Factors in some maintenance sectors such as communication and teamwork that may seriously affect safety.

This training must also encourage a positive attitude towards all the improvement approaches of safety and put off the adverse practices.

This human factors training is one of the major issues of the approach related to human factors.

If the measures related to the human factors approach correspond to concrete actions mainly aiming at the adaptation of environment, tooling, information (maintenance data, work card, procedure…) and the adaptation of work to personnel (preparation, instructions handover, team organisation), the human factors training of the organisation's personnel is essential in many ways and enables to ensure the actual taking into account of Human Factors related principles in organisations.

8.1 **Personnel to be trained**

As a whole, the Safety policy and the Human Factors approach can have a long term efficiency only if the whole personnel are made aware and trained for human factors and understand the importance and the stakes of human factors for them, for the company and for safety in general.
According to AMC 145.A.30 (e), the persons involved in this training are listed as follows:

- Maintenance post-holder, managers and supervisors,
- Certifying staff, technicians including the personnel involved in specialised activities,
- Technical support personnel such as technical office, preparation, planning, logistics personnel,
- Quality control and auditors staff,
- Human Factors dedicated personnel (Human factors manager, human factors coordinators..),
- Human factors trainers, other technical trainers, persons in charge of defining the needs in human factors and all the persons lead to assess other persons,
- The Maintenance Safety system personnel (manager / coordinators, accident/incident investigators),
- External personnel when necessary (temporary personnel, non-approved subcontractor working under the Quality system).

Even if it is not especially specified in Part 145, the Accountable Manager, who must have a good understanding of his/her commitment towards the organisation, is also involved in the training or at least being made aware of Human Factors.

Human factors training should not be organised to meet a punctual need but a constant need of the organisation.

### 8.2 Training syllabus

The human factors training syllabus presented in GM 145.A.30 (e) introduces the practical issues to be known within a Part 145 approved organisation.

This syllabus is mainly focused on human performance and its limitations (themes 1 through 9 below) and deals with the systems implemented by the organisations to take human factors into account (theme 10 below).

The Human Factors training syllabus implemented in Part 145 organisations must be developed incorporating as many practical examples as possible that will rely on the trainer's experience, but also on the pieces of information collected within the organisation or from other organisations.

Theme 10 of the Part 145 human factors syllabus gives the personnel the concret measures taken in the company regarding the Safety related approach and the human factors related approach.

As specified formerly, any person in the organisation must get an initial training. These initial trainings must be built according to the initial training syllabus themes presented in § 8.2 taking into account the population of the personnel to be trained.

In any case, these trainings should be established according to the scope of the organisation, complexity of the tasks and error risk, experience of the organisation on problems related to human factors, incidents and significant errors having involved the organisation.
Human Factors
Training Syllabus

1 General and Introduction to Human Factors
1.1 Need to address human factors
1.2 Statistics
1.3 Incidents

2 Safety Culture / Organisational Factors

3 Human Errors
3.1 Error theories and models
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 and 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–practices/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 Human Factors Approach
10.1 Reporting errors
10.2 Reporting encouragement policy
10.3 Error investigation
10.4 Action to address problems
10.5 Feedback
8.3 Initial Training and Continuous Training

Part 145.A.30 refers to a notion of initial training and to a notion of continuous training.

Initial training addresses all the personnel of the organisation. It is specified in AMC 145.A.30 (e) that such personnel must be assessed to know the needs and give them an initial training in human factors and that in any case, continuous training regards all the personnel involved.

This notion of assessment before initial training enables to adapt the training to the need. For instance, if some persons already have had an initial training on human factors within the company in the past or in a former company, in this case, it is not necessary to give them again a complete initial training.

Human factors training in Part 66 must be regarded as a basic training but does not make up the human factors initial training of Part 145. The initial training given to personnel having had such a basic training could be lightened taking the knowledge already acquired into account.

In any case, an additional training embodying the organisation's specificities and the means implemented to take human factors into account, will have to be given to the new comer before validating his/her initial training.

8.3.1 Initial Training

This training must be adapted, in depth and length, to the size and activity of the company, the type of personnel to be trained and the function they ensure.

By regulations, the personnel involved must be trained at least within 6 months after being hired including the temporary workers, according to the duration of their assignment. However, it is recommended that this training should be carried out before the persons involved are enabled to work by themselves.

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| The duration, content and quality of the initial training should be adapted to the nature of the organisation and to the population involved. |
| Experience shows that the average duration to cover the whole initial training syllabus at a good level of detail is of 2 days but can vary between 1 and 3 days knowing that the content of the training is as important as the duration of the training. |
| For personnel directly involved in human factors (human factors issues manager, safety investigators...) longer initial trainings should be anticipated (from 3 to 5 days). |
| An initial training with duration between half a day to one day can be acceptable for personnel with credits of a Human Factors training formerly obtained or for personnel not involved by all the subjects of the initial syllabus (e.g. logistics agents) or in the case of a more frequent continuous training system. |
8.3.2 Continuous Training

According to AMC 145.A.30 (e), the object of continuous training is to make sure that the whole personnel is up to date in human factors knowledge and also to collect feedback on the issue.

The notion of feedback in this continuous training is primordial. It enables the trainers to take into account the problems related to human factors and safety met on the field and to pass on these pieces of information to the Quality system and to the management so that adapted actions can be undertaken.

It also enables the technicians to be informed on instructive accidents / incidents on the issue.

Continuous trainings of instructors, responsible for the Human Factors approach can be ensured through conferences, seminars or working groups on human factors.

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| The formalised duration of training should be at least of one day every 2 years, it can however change according to the means implemented for its issue and the nature of the organisation (DVD, magazine, kiosk, dedicated intranet site…). |

8.4 Profile of the Instructors

Human Factors instructors play an essential role in the success of the implementation of a human factors approach in the company.

It up to them to inculcate « HF culture » to the personnel persuading them that voluntary, individual and continuous approach participation to the Human Factors approach will highly contribute to the improvement of flight safety.

Regarding human factors training, it is important to have instructors that feel the interest of human factors and who are credible enough to transmit the message to the personnel. These personnel must know how to listen to the personnel in training.

It is sometimes better for such instructors to be independent of the activity where the personnel to be trained work thus enabling the personnel to confide more easily without fearing judgements on their performance.

Furthermore, it is also important that these instructors should be actually acknowledged in the company and that they enjoy a kind of legitimacy. It will later on enable persons facing errors / human factors related matters to refer to the information transmitted by the instructor involved in the case of discussion with his/her management.

The instructors should on another hand fulfil the following requirements:

- Having undergone a formalised training for the training activity and having been assessed or already performed trainings,
- Having worked for at least 3 years in a maintenance organisation,
- Having got a detailed initial training on human factors covering the syllabus of Part 145.

The initial training on human factors should be as exhaustive as possible for the instructors. A human factors training of the instructors only centred on theoretical aspects would not be acceptable.
This training should enable the instructors to be informed of information / communication video media available on human factors, to analyse specific cases of incidents / accidents related to maintenance errors. It is important to recall that this training aims before all at the evolutions of minds, to change some individual attitudes within an organisation rather than transmit a detailed knowledge on a given area. That is why, it is important for the trainer to be before all very involved in the issue, credible, respected, able to acknowledge these limits, his own errors. These features are as important as the detailed expertise in human factors issues. In this context, it is more logical to have volunteer instructors intervening for this training rather than appointing instructors who would not be necessarily at home in this type of training.

8.5 External Training

It would be desirable for maintenance organisations to have one or more internal Human Factors instructors. They can keep themselves informed of the evolution of the organisation regarding human factors related aspects and occurrences (incidents, errors…) and thus be close to the individuals and training needs in this area. These HF instructors in charge of internal HF training of the organisation's personnel should logically be themselves trained by external training organisations.

However, as specified in Part 145.A.30, human factors training can in some cases be conducted independent trainers even training organisations or other Part 145 maintenance organisations that must be accepted by the authority.

Some companies may be unable to have internal HF instructors and need in such case to use external instructors (independent ones / training organisations) to train the whole organisation's personnel on human factors.

The preparation of the training should bring the customer company and the external instructor to meet before such training so that the instructor can take into account the issues related to the company and the specific occurrences that took place in the company in the area of human factors to incorporate them in the training. A phase of observation of the actual activity of the company by the external contributors is recommended.

External HF instructors should logically meet the same criteria than those presented in § 8.4 for internal instructors.

About external training acceptance:

Part 145 approved organisations giving their own internal HF training and Part 147 base-approved organisations are both acceptable to the Authority.

In order to be acceptable to Authority, other training organisations or independent instructors shall meet the criteria below. A Part 145 approved organisation willing to use a non Part 147/base or a non Part 145 approved organisation or an independent instructor must check that they meet the criteria before they can be authorised to perform HF training in the maintenance organisation. These criteria must be included in the MOE.
### Competence

<table>
<thead>
<tr>
<th>Competence</th>
<th>Competence fundamental Criteria to deliver an initial FH Training</th>
<th>Others equivalents criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedagogy</td>
<td>Diploma recognized by the Department of Education in the professional training field or equivalent.</td>
<td>To have at least 3 years of experience as adults trainer in a professional field.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Justify of knowledge of the field practises maintenance (e.g.: professional experience, work or studies carried out, immersion in company...).</td>
<td>To have at least 3 years of experience in aeronautical maintenance.</td>
</tr>
<tr>
<td>Risk management and Human factors</td>
<td>Diploma recognized by the Department of Education (at least of the University level Diploma (DU) or Master) in one of the human sciences fields.</td>
<td>To have received a HF training of at least 60 hours in this domain</td>
</tr>
</tbody>
</table>

Required competences apply to the organization in charge to deliver the training. The criteria of acceptance are thus judged in a total way and not in an individual way.

The external training organisation and the independent instructors must show that they respect the principles related to the training as described in this chapter. In complement of the general terms of reference above, these companies must be able to evaluate the culture "safety" of a company and the FH actions already taken by this company and to have the capacity to build a FH training support adapted to this company.

If the phase of preparation of this FH training by the external trainer with the workshop is of primary importance, designated people of the workshop intervening in the "Safety/ HF" approach (HF coordinator, Safety/HF manager..) should also take part in the training courses of the personnel of the workshop in order to assist the external trainer on all the questions relating to maintenance in general and the specific activity of maintenance of the workshop.

This principle is all the more significant in the case of trainer external having the basic competences deepened in HF aspects without having very significant aeronautical maintenance experience practises.

Some information developed in this chapter can be specified in the human factors training procedure that must be described in chapter 3.13 of the MOE.

Further more detailed information can be obtained on these issues by reading chapter 5 and appendices A and B of chapter 5 of the ICAO report doc 9824 and chapter 11 and appendices U, V, W of the CAP 716 guide and appendix 7 of the JAA document.
9. TAKING HUMAN FACTORS INTO ACCOUNT IN THE MANAGEMENT, SUPPLY AND USE OF MATERIALS (145.A.40)

According to Part 145.A.40, all the equipment, tools and material shall be available where necessary. There is not much information on the matter in Human Factors referential.

Furthermore, the availability of the material is mainly underscored and not the compliance of such equipment according to the individuals' limitations.

This reason certainly comes from the fact that the main means made available for the technicians (specific tools) are as a whole designed by the manufacturer of the aircraft who usually has enough experience on the matter to design tools adapted to individuals.

9.1 Material involved

The organisation should all the same pay attention on the issue in the frame for instance of the following means designed internally/externally:

| Substitution tools, |
| Big sized / high volume tools (falling hazard), |
| Lifting tools, |
| Access to the aircraft (adaptation of docks, work stands, lit platform …). |

9.2 Reporting of defects noted on material

Part 145 recommends the implementation of different reporting systems in order to feedback all observations associated to inadequate maintenance data and procedures and all the occurrences associated to errors of execution of tasks. Even if Part 145 does not specify it precisely, it sounds logical to anticipate an information feedback system enabling the personnel themselves to report the findings made on problems related to tools, test benches..

The organisations must therefore implement a specific reporting system of the problems related to tools or maybe use the error/incident reporting system required in Part 145.A.60.

The advantage of the first solution is to have a sole and single error reporting procedure within the organisation (errors/occurrences, unsuitable procedures, unsuitable maintenance data, unsuitable environment, unsuitable tools...).

It is however advised to make a difference between these two reporting systems in order to manage priorities, to address directly the tools related reports to the service in charge of their maintenance without using an intermediary service (e.g. Safety System).

Further more detailed information can be obtained on these issues by reading chapter 3 and appendices E and F of chapter 3 of the ICAO report doc 9824 and chapter 5 and appendices Q and M of the CAP 716 guide.
10. REDACTION OF PROCEDURES TAKING INTO ACCOUNT THE PRINCIPLES RELATED TO HUMAN FACTORS AND REPORTING SYSTEM OF THE ERRORS OR AMBIGUITIES OBSERVED ON THE MAINTENANCE PROCEDURES (145.A.65)

10. 1 Redaction of the procedures

Part 145.A.65 (b) requires that the organisation shall establish procedures agreed by the competent authority taking into account human factors and human performance to ensure good maintenance practices and compliance with this Part 145. It is also specified that all the technical procedures must be written taking into account rules from human factors.

It is shown that an important number of maintenance errors come from the non-enforcement of the current procedures.

The reasons for that are various and can be summed up as follows:

- Procedures out-of-date,
- Procedures not practical (too restrictive, too time consuming for the time allotted),
- Procedures not optimised (no necessarily describing the best way to do the work efficiently),
- Procedures ill presented (too complex ones, useful information difficult to use and to find...),
- Difficult access to the procedures (difficulty in finding the procedure sought, unawareness that the procedure sought exists...),
- Inadequate policy of use of the procedures (personnel not aware of the necessity to follow the procedures..),
- Incorrect practices of the use of the procedures (experienced personnel feeling as a whole not to need them, preferring using their own expertises and experience, assuming knowing the procedures involved…)

Many errors related to the enforcement of the procedures come from the procedures themselves.

In a lot of cases, analysing the content and the form of the procedures, taking the place of the end user, one can note that they are not entirely well adapted.

10.1.1 Presentation of the procedures

The form of the procedures is crucial for a proper use and avoiding errors of enforcement.

The rules advised to present the procedures are as follows:

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| Use standard sized pages (A4), |
| Text in column, |
| Ideally, sentences of 10 to 12 words, |
| Left / right margins large enough, |
| Numbering the pages at the right top / bottom, |
| Left justification of the text, |
| Each paragraph must be numbered (1, 1.1, 1.1.1 …), |
| Leave enough space between the titles, paragraphs, |
| Use a font of enough size and legible (e.g.: « Times New Roman ») avoiding different fonts on a same procedure, |
| Font size between 9 and 12 with a preference for 11, |
| Emphasising some words must be advisedly used. The use bold characters or underlining is often preferable, |
| Minimise uppercase in the text of the procedures. |
10.1.2 Content of the procedures

The rules recommended to write the content and amend the procedures are as follows:

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- Take into account the opinion of maintenance personnel who have good knowledge on the subject,
- Any procedure must be checked on the field and validated before being used,
- Check that the procedures are up-to-date, usable and define proper practice,
- Adapt the procedures to the level of expertise of end users,
- Take into account the environmental aspects in which the procedures must be used,
- Check that all the key-points are presented in the procedures and avoid writing complex procedures,
- Explain the reasons for the procedure,
- The order of the tasks and stages must reflect the proper way and must follow the logic of the process,
- Anticipate grouping tasks enabling to inscribe the situation of the work involved and maybe its interruption,
- Ensure homogeneity and consistency in the design of the procedures and the use of abbreviations, terminologies, and references…
- If possible, try and limit every procedure or group of tasks on one page,
- Include clear titles at the top of each page or group of tasks,
- In the case of revision of procedures, specify the changes of content (left line or code in front of each modification) and write the date of the revision on the page (top or bottom of the page),
- Avoid cross-references by duplicating some information at several places (the procedure updating system must take this point into account),
- Logical flow charts must be clear and justify in most cases logigrams that must anticipate all the cases,
- Diagrams, tables of data, drawings, pictures and photos can be very useful and enable to communicate a great deal of information. Taking some precautions on the subject (presentation, data positioning / diagrams, pictures / texts, titles, references...),
- Include information of the type « alarms », « cautions », « notes » enabling to insist on some specific points and avoiding some errors. Place this type of information, if possible, just above the text to which it refers and on the same page than it,
- If possible, anticipate check boxes in the procedures enabling the users to specify the tasks or groups of tasks already carried out,
- In the case of handwritten information, leave enough space in the procedures involved to do so,
- Avoid different terms for a same word,
- Use specific words, not ambiguous ones for people required to use these procedures,
- Avoid abbreviations and in any case anticipate a glossary easy to access to,
- Write in a clear, simple and precise and easily understandable way,
- Include one or two phrases of summary before a long text to give the main ideas,
- Anticipate short sentences associated to an idea,
- Avoid negative sentences and use verbs of action,
- The sentences must answer the questions "who" and "what",
- Ensure that the printing or the photocopy of these procedures is of good quality,

*Further more detailed information can be obtained on these issues by reading chapter 3 and appendix G of chapter 3 of the ICAO doc 9824 and chapters 3 and 6 and appendix S of the CAP 716 guide and appendix 4 of the JAA document.*
10.2 Notification of the defects noted on procedures

AMC 145.A.65 (b) requires the implementation of an internal reporting system of the defects noted by the technicians on internal procedures.

The organisations must therefore either implement a specific system to report the ambiguities associated to the procedures or to use the error/incident reporting system required in Part 145.A.60.

The advantage of the first solution is to have a sole and single error reporting procedure in the organisation (errors/occurrences, unsuitable procedures, unsuitable maintenance data…). It is however advised to make a difference between these two reporting systems in order to manage the priorities, to address directly these environment related reports to the service in charge of their maintenance without using an intermediary service (e.g. Safety System).

This procedure can be described in chapter 2.27 of the MOE (if the title of this chapter is generalised to the « reporting procedure by the personnel of data, procedures, infrastructure, tooling inadequacies... »)

Further detailed information can be obtained on these issues by reading chapter 3 and its appendix G of the ICAO report doc 9824 and chapter 3 and 6 of appendix G of the CAP 716 guide and appendix 4 of the JAA document.
11. SYSTEM TO REPORT THE ERRORS OR AMBIGUITIES OBSERVED ON MAINTENANCE DATA (145.A.45 / 145.A.65)

Part 145.A.45 (a) requires maintenance data to be easily accessible, close to the work performed with enough reading means (reading, PC...).

This paragraph mainly refers to all the maintenance data published by type certificate holders or supplemental type certificate holders (TCH or STC holder or TSO holder) or Part 21 design organisations.

On another hand, this chapter also regards maintenance organisations because of the changes of maintenance data that they are enabled to do under the conditions of 145.A.45 (d) and because they may be led to write work cards under the conditions of 145.A.45 (e) that can be directly made from the manufacturer's maintenance data in which errors of form or mistakes can appear.

11.1 Redaction of technical instructions

According to AMC 145.A.65 (b) the organisation is required to establish technical procedures taking rules from human factors into account.

As for the procedures, the organisation led to write technical instructions based on published maintenance data (e.g.: AMM) must ensure that the wording and rules of presentation of the technical instructions follow those related to human factors already specified in §10.1.1 (content of instructions) and 10.1.2 (presentation of instructions).

11.2 Training for the use of technical instructions / maintenance data

The personnel must be trained to use and make the records associated to these instructions:

- Train the users on the systems to read and issue the procedures.
- Train the users on the documentary structure.
- Take properly linguistic issues into account (training, continuous assessment…) if documentation in a foreign language is used.
- Convince the personnel of the necessity of finishing a group of specific tasks before interrupting a procedure,
- Encourage the personnel to specify on the procedure each task or group of tasks already performed,
- Insist on the importance of wording properly and legibly the information so that they can be processed later on by other persons (uppercase, black pen, avoid abbreviations, specific information…).

11.3 Internal reporting of ambiguities on internal instructions and maintenance data.

Part 145.A.45 (c) requires that the organisation shall establish procedures to ensure that if found, any inaccurate, incomplete or ambiguous procedure, practice, information or maintenance instruction contained in the maintenance data used by the maintenance personnel is recorded and notified to the author of the maintenance data.

By default, according to part 145, this reporting system addresses more especially the manufacturers publishing basics maintenance data (AMM, SRM, CMM…).

It is acknowledged that the maintenance manuals provided by the manufacturers often require revisions, improvements. Ideally, these manuals should be validated during the initial issue, for each type of aircraft and evolutions but this is not systematically made. That is why, the principle held is to use the operator's and workshop's experience in order to make changes in these manuals.
That is why, it is important to implement a system to record (at the source) and report the ambiguities and lack of information, information that must transmitted to the TCH to update the associated documentation.

The personnel must be encouraged to report this type of errors being be quite sure that such reports are useful.

It seems logical that this requirement also involves internal technical instructions and therefore the authors of these data (e.g. Technical office).

The organisations must therefore either use the basic error / incident reporting system (145.A.60) required in Part145 or to create a specific system related to the ambiguities of the technical instructions and data published by the manufacturers.

The advantage of the first solution is to have a sole and single error reporting procedure in the organisation (errors/occurrences, unsuitable procedures, unsuitable maintenance data, unsuitable environment…). It is however advised to make a difference between these two reporting systems in order to manage the priorities, to address directly these environment related reports to the service in charge of their maintenance without using an intermediary service (e.g. Safety System).

Some issues developed in this chapter can be specified in the procedure related to the ambiguities/errors on maintenance data that must be described in the MOE Chapter 2.27.

Further more detailed information can be obtained on these issues by reading chapter 3 and its appendix G of the ICAO report doc 9824 and chapters 3 and 6 of appendix G of the CAP 716 guide and appendix 4 of the JAA document.
12. **PLANNING AND PREPARATION SYSTEM (145.A.47)**

In Part 145.A.47 (a), it is specified that the organisation shall have a system appropriate to the amount and complexity of work to plan the availability of all necessary personnel, tools, equipment, material, maintenance data and facilities to ensure the safe completion of the maintenance work.

The planning function is essential to ensure properly a maintenance activity. This function uses the notions of human factors in many ways.

It is essential to ensure that there are enough adapted personnel and that the various means will be available at the right place at the right time to complete the work.

The object of this notion included in Part 145 is not to explain how planning / preparation personnel will have to carry out their work but rather to put forward some human factors related issues that they will have to take into account within their activities such as human performances limitations.

As specified in AMC145.A.47 (a), depending on the amount and complexity of work performed, the planning / preparation system may range from a simple system included in the Production activity to a service dedicated to this function helping Production.

As specified in the same AMC, the functions planning and preparation must deal with the following items:

- Availability of human resources (link with Part 145.A.30 (d) / workload plan),
- Logistics (minimum equipment, preparation of standard material, checking the availability of necessary tools…),
- Working zone (hangar room, access…),
- Documentation (work package, work cards, AMM, SB…),
- Organization (avoid anticipating complex tasks at night or very early in the morning),
- Coordination of the interventions of internal and subcontracted services.

It is important that the planning personnel should be able to follow the human factors training to know the consequences on human performance and therefore the impact of a good or bad preparation of inspections on safety.

This information can be presented in the procedure of chapter 2.28 of the MOE.

Further more detailed information can be obtained on these issues by reading chapter 4 and its appendix I of the ICAO report doc 9824 and chapter 8 of the CAP 716 guide.
13 TAKING HUMAN FACTORS PERFORMANCE AND LIMITATIONS INTO ACCOUNT IN MAINTENANCE PLANNING (147.A.47)

According to Part 145.A.47 (b), the planning of maintenance tasks, and the organising of shifts, shall take into account human performances limitations. Performance limitations especially involved regard those that must be taken into account to organise work teams, working hours, shifts and are therefore closely related to the notion of fatigue.

It is obvious that if the notion of fatigue is certainly the most general one to be taken into account in the preparation and follow-up of work, the other human performances and limitations should also be properly dealt with by the organisations. If the visual, auditory performance, the health related aspects are assessed in a regular and general way (e.g. occupational medicine), the points on which the companies must be especially cautious are those related to alcohol, drug and self-medication.

13.1 Type of Fatigue

The term of fatigue can be of different types, that is:
- Physical fatigue (e.g. muscular, lack of oxygen, lack of sleep, illness, bad nutrition…),
- Mental fatigue (e.g.: associated to tasks requiring intense concentration, analysis and process of complex data / information…)
- Emotional fatigue (e.g.: working under constant pressure, undergoing continuous critics…)

It is often difficult to tell the different types of fatigue. On another hand, it is useful and easier to make out some classical fatigue related signs.
In any case, the notion of fatigue can only be acknowledged by experience because it is not practically quantifiable. The sole mean to assess it can only be done on its effects.

13.2 Symptoms of Fatigue

The classical symptoms of fatigue are:
- Lack of awareness,
- Diminished movement capacity,
- Diminished vision,
- Slow reactions,
- Short-term memory problems,
- Too limited concentration losing an overview of the situation,
- Easily distracted by different things,
- Increased mistakes,
- Poor judgement,
- Inadequate decisions or no decision at all,
- Abnormal moods.

One of the prevailing factors playing a role in fatigue is related to working hours and shift working (2x8, 3x8).

Several studies show a significant increase of the risk of errors in the case of shifts with long working hours and night shifts knowing that these risks increase significantly when these types of shift are cumulated.
13.3 Working Hours / Shift Work Organisation

The main points required to minimise the effects of the fatigue of the personnel working in shift are as follows:

- Avoid excessive shift working periods,
- Anticipate enough amount of night sleep,
- Minimise sleep loss,
- Give the opportunity for extended rest when night sleep has been disrupted,
- Take into account reduced physical and mental capacity at night,
- Take into account individual situations,
- Provide enough support / help to the technicians outside administrative periods,
- Give the opportunity for recovery,
- Overall minimisation of night shifts,
- Provide longer rest periods after night shifts,
- Launch the most complex tasks generally during the day,
- Ensure that appropriate checks are made after night shifts,
- Avoid repetitive tasks over a long period or anticipate intermediary breaks.

Studies enabled to draw great principles, which can be used to implement an organisation of work taking into account human performance and limitations.

To follow the hierarchy of standards, the maintenance organisation must reconcile the requirement related to labour regulations with Human factors related principles and their operational requirements.

**For Information Only (the 15 recommendation of the ICAO document 9824- Chapter 3, Appendix H)**

- No scheduled shift should exceed 12 hours work,
- No shift should be extended beyond a total of 13 hours work by overtime (case of an unforeseeable occurrence),
- Between two shifts, a minimum rest period of 11 hours should be anticipated,
- It is recommended to respect a maximum of 4 hours work before a break,
- A minimum break period should be at least of 10 minutes plus 5 minutes for each hour worked since the start of the work period or the last break,
- Scheduled working hours should not exceed 48 hours in any period of 7 successive days,
- The total work should not exceed 60 hours or 7 successive work days before a period of rest days,
- A period of rest days should include a minimum of 2 successive rest days continuous with the 11 hours off between shifts.
- If possible, a total of 28 days of annual leave should be granted. This period should not be less than 21 days a year.
- To limit the increase of risks associated to night work, the number of successive night shifts should be limited taking into account the average duration of the shifts (maximum 6 shifts of 8 hours, maximum 4 shifts between 8 and 10 hours, maximum 2 shifts of 12 hours),
- A working cycle including night work should be followed by a minimum of 2 successive rest days continuous with 11 hours off between shifts (i.e. a minimum of 59 hours off). 3 days of rest should be anticipated after a cycle including 3 shifts with night work,
- The finish time of the night shift should not be later than 0800 hours,
- A morning or day shift should be scheduled to start before 0600 hours and, wherever possible, should be delayed to start between 0700 and 0800 hours,
- A series of morning or day shifts starting before 0700 hours should be limited to 4 before a 2 days rest period,
- If possible, the mechanics’ working schedule should be communicated at least 28 days before.
If these points are logically all respected as a whole in the current operation of companies, maintenance organisations must be especially careful on the matter especially during exceptional situations with high commercial stress or very important operational stress (working time of emergency repair teams / No Go aircraft in a far stop-over, end of aircraft check…).

Some elements developed in this Chapter could be specified in the procedure described in Chapter 2.28 of the MOE.

Further more detailed information and additional recommendations can be obtained on these issues by reading chapter 3 and appendix H of chapter 3 of the ICAO report doc 9824 and chapter 4 and 8 and appendices N and P of the CAP 716 guide and appendix 5 of the JAA document.
14. INSTRUCTIONS HANOVER (145.A.47)

As specified in Part 145.A.47 (c), when it is required to hand over the continuation or completion of maintenance tasks for reasons of a shift or personnel changeover, relevant information shall be adequately communicated between outgoing and incoming personnel.

As a whole, the communication aspect within the maintenance activity is important taking into account the various different contributors.

It was shown that communication deficiency is one of the factors related to several accidents and incidents.

Oral communication enables to discuss the works in progress, confirm the actions taken or remaining to be taken, transmit specific instructions, coordinate the actions of several contributors and being simply « in relation » and operate the teams and persons together (motivation, dialogue…).

If this oral communication is important, written communication keeps a crucial place in the maintenance activity because of the complexity of the information transmitted, of the necessity for the proper progress of works and for a general traceability issue. This written communication is already for a great part structured in the area of maintenance (AMM, inspection file, work cards, certificates…).

14.1 Instructions handover – works interrupted during a shift

The notion of instructions handover should be organised as specified above during team / shift changeovers.

On another hand, it is also important to include in the organisation of works, this notion of instructions handover in the case of works interrupted during a shift.

Two cases are to be taken into account:

- Taking into account by a new person of a task or group of tasks already being carried out.
  
  In this case, the instructions handover among the technicians must be made orally and by writing. As a whole, it is better to be on the working area to do so. Regarding the handover of written instructions, working documents must logically meet the needs of information on the situation of the work (refer to signing off tasks).

  
  Interruption of a task during a shift without it being undertaken by someone else or by the same shift.

  This case should logically be limited at maximum for cases of extreme emergency. In any case, it is logical to complete at least the task or group of tasks in progress in order to be able to sign them off on the associated work card (see signing off tasks). In this case, the instructions handover which cannot be made orally directly between the involved technicians, the written instruction have a greater importance.

  The technician who has to interrupt his work must take the necessary steps so that the written instruction related to the situation of his work are recorded (for instance at the level of the work/launching manager) specifying in addition of the information on the status of the tasks on the work cards the other necessary information (situation of the parts removed, tools, problems met…).
14.2 Instructions handover during shift changes

One of the important points introduced in Part 145 on the issue refers to the instructions handover among shifts.

It is acknowledged that within shift changes the need for an efficient communication between the « outgoing » team and the « incoming » team is extremely important in the maintenance activity.

Some rules in the case of instructions handover among shifts should be enforced:

- The persons must be physically able to hand over information in writing, orally or by signs. Using just one way to hand over information may lead to errors of interpretation, information forgotten. The use of two means to hand over information reduces the risks,
- Two-way communication enables to check everyone’s understanding regarding the messages to be transmitted,
- The instructions handover system can also take into account the fact that some persons resume work after having been away from the company even for a short while,
- This system must be adapted to the types of contributors (level of experience, speciality…),
- Written communication can be helped by supports specifying the type of useful information to be transmitted (check list),
- Transmitting key-points of the messages and avoiding any useless information in order to be able to memorise and use properly this information afterwards,
- Information must be clear, easy and accurate,
- In the case of instructions handover that cannot be made orally (case of afternoon shift with morning shift), anticipate an appropriate communication system with complimentary means so that no doubt remains.
- Organise a meeting to hand over instructions between the managers of the outgoing and incoming shifts in order to hand over significant information on the works in progress and the associated problems and actions to be planned. This meeting must be held in a place with enough space and stillness to ensure proper communication.
- During shift changeover, given in some cases the great amount of work, it is important to ease the instructions handover by implementing a system of labels on work cards or by segregating work cards in order to know exactly the works remaining to be done, the works not launched, the works in progress and those already completed,
- Also plan additional meetings between foremen / certifying staff to handover the instructions. These meetings must this time be concentrated on the maintenance works and tasks completed, in progress and to be carried out. For these instructions handover to be most efficient, it is advised that a part of these meetings should be held directly on the workplaces,
- The time to be planned for these meetings should be long enough (15 to 30 min).

These issues developed in this chapter can be specified in the procedure of chapter 2.26 of the MOE.

Further more detailed information can be obtained on these issues by reading chapter 3 and appendix B of chapter 3 of the ICAO report doc 9824 and chapter 7 and appendix T of the CAP 716 guide.
15. SIGNING OFF TASKS (145.A.65)

AMC145.65 (b)(3) requires that to prevent omissions, every maintenance task or group of tasks should be signed off after completion.

The aim being to know the situation of the tasks or group of tasks completed or remaining to be done, it is important that these tasks or group of tasks should be signed off just after their completion and of course neither before nor at the end of the work in progress/work card. The requirement to sign off a task or group of tasks should be properly specified to the technicians on work documents. A signature requirement should clearly appear on the work document (signed, specific box…).

This principle of signing off elementary tasks or group of tasks enables the interruption of a work card by a person (end of shift, meal, break, reallocation…) to be resumed by this same person or another one knowing precisely the tasks remaining to be done.

It should be clear for the technicians that it is required to finish entirely a task or group of tasks to be able to sign off this task or group of tasks and this before interrupting the task for any reason.

Uphill, the rules should be defined by the organisation enabling the writers of work cards to know in which cases (nature of works, airworthiness hazards in case of errors, complexity, duration of work…) it is required to plan possibilities of intermediary signatures on these work cards.

In the same way, procedures related to the record by technicians of the progress of works (intermediary signatures) by using either work cards or directly manufacturers' technical instructions (e.g.: AMM, CMM…) must be developed and made available for the technicians. The maintenance organisation must ensure that all the technicians have a proper understanding and a homogenous practice of the traceability of works.

It is important to raise the personnel's awareness on this aspect. This notion of intermediary and final signature must be understood as a necessary means to have a clear status of the work in progress. This must not be taken as a means of identifying the responsible person for an incident for instance. It is on another hand obvious that this system may generate an increase of workload in paperwork whose costs can in no case be compared to those generated by an incident.

Further more detailed information can be obtained on these issues by reading chapter 3 and its appendix C of the ICAO report doc 9824 and chapter 7 and appendix T of the CAP 716 guide.
According to Part 145.A.60 (b), the organisation shall establish an internal occurrence reporting system as detailed in the exposition to enable the collection and evaluation of such reports, including the assessment and extraction of those occurrences to be reported to the authorities, manufacturers and customers.

This procedure must identify adverse trends, corrective action taken or to be taken by the organisation to address deficiencies and include evaluation of all known relevant information relating to such occurrences and a method to circulate the information as necessary.

As specified in AMC 145.A.60 (b), the aim of this system is to identify the factors contributing to occurrences and to make the system « resistant to errors ».

This SAGES system must provide anyone in the organisation with the possibility of freely reporting any safety related occurrence whether an observed or a potential one.

This will be facilitated by the implementation of a policy encouraging the reporting of safety related errors. The personnel must be convinced that they will not be punished for having reported a maintenance error, not known otherwise, that they noted, made or nearly made or for having cooperated in a safety related enquiry.

It is also important for this system to be reactive and process quickly all the required corrective actions following the reports involved.

The effective implementation of these corrective actions is important but the organisation must also implement a feedback system to the persons having reported the occurrences but also to all the personnel of the organisation. This condition enables to ensure the continuity of the system as a whole, which is based before all on each individual's motivation and commitment on the issue.

Up till now, in most cases, internal reporting systems were very centred on major incidents in operation of technical origin (engine shutdown, loss of an hydraulic system…) and on the major technical findings noted on the aircraft or equipment during their maintenance (test failure of a safety system, crack/outstanding defects…) and likely to have possible negative consequences on airworthiness. This information are meant, before all, for the manufacturers and authorities and are as a whole related to design and production problems of the products involved and sometimes related to maintenance errors.

Significant occurrences in operation (return to parking, return flight, engine shutdown, flights cancelled, important delays…) that should not necessarily be externally reported, are as a whole, analysed by the companies but too often with the idea of pointing at the responsible sectors of the organisation. Furthermore, in addition to these occurrences, there are many errors that do not necessarily cause immediate incidents / operational consequences and that are seldom studied.

In order to have a better understanding of the problems and factors that might contribute to errors, it is necessary to analyse all these occurrences before such occurrences in quantity and/or cumulated provoke serious incidents or accidents.

The analysis of these occurrences should not only be used to see what happened (What?) but also to identify the persons / activities directly involved (Who?) as well as determining the contributory causes and factors (Why?).

The internal reporting system mentioned in this chapter must enable any member of the organisation to report formally these maintenance errors or significant maintenance errors risks…
16.1 Organisation related to reporting system

The occurrence reporting system must be the object of the implementation of an organisation, procedures, specific means.

The organisation must appoint the persons in charge of processing the maintenance errors reporting.

These persons who must be before all, impartial, objective and independent, should have appropriate skills in the area of communication, in carrying out interviews of the personnel involved by these occurrences, as well as in the collection, analysis and compilation of the information available on the subject.

In order to be able to make an enquiry on the occurrences, they should have enough technical knowledge to understand the aircraft systems involved, the related technical documentation and the maintenance procedures applicable in an organisation and if necessary, to get some help from personnel having special knowledge in the process of some files.

These persons should have enough legitimacy to enable them to get any document / information related to the occurrences to study and to be able to meet freely the persons from different sectors of the organisation.

As presented in chapter 4, the analysis and follow up of occurrences related to errors or important risks of errors should be allocated, if it exists, to the Maintenance Safety System of the organisation.

16.2 Key items of the system of internal reporting

An occurrence reporting system should include the following items:

- An accurate definition of the object and objectives of this system,
- A clear and formalised commitment of the management to operate such a system,
- An overall encouragement in the company for the personnel to take part in this system without self-censorship of the reporting,
- Definition and publication of a policy of encouragement of maintenance error reporting,
- A process of investigation of the occurrences,
- The types of occurrences that should trigger investigations,
- Selection and training of the investigators,
- Information, even training, of the personnel towards the internal occurrence reporting system,
- Implementation of appropriate actions after investigations,
- Feedback to personnel,
- Analysis of the information got via this system in order to check the trends and the frequencies of apparition.
16.3 Policy of encouragement to report maintenance errors

This notion to encourage error reporting is a crucial item for the implementation of the SAGES. It is a clear, accurate, formal, written commitment from the Management.

The only way to know the genuine contributory factors of an occurrence is to get from the individuals involved maximum precisions on the actual situation at the time of the occurrence including their personal situation (family situation, illness, cumulated fatigue…). This information that must remain confidential are meant to enable persons in charge of the analysis to identify and analyse the most important contributory factors and to recommend appropriate and really efficient actions. The quality of this information mostly relies on the freedom of speech of the persons involved.

That is why, in order to make easier information feedback, the organisations must ensure that the personnel will not be punished for having made or reported maintenance errors not known otherwise. This regards the errors they reported, committed or nearly committed, or the error appearing because of their cooperation within an enquiry related to a reported error.
It is advisable that this commitment should be very widely published within the organisation by the Management of the organisation and actually implemented.

Complementarily, it must be clear in this policy that an additional training measure decided after a HF enquiry is in no way a punishment.

Secondly, the Human Factors enquiry on maintenance errors must rely on a clearly identified process using a specific vocabulary. It must enable to determine the characteristics of the error and to assess the responsibility of the person(s) involved.

In order to make a difference in the cases, the « test of substitution » method can be used. It consists in determining whether one or more persons having got the same training, the same experience, the same privileges or responsibilities as the directly involved person could have under the same circumstances (environmental, related to the means, personal situation…) committed the same error than the latter.

In appendix III there is an example of a system to help determining the level of implication in cases of safety related significant errors as well as a glossary enabling to define the different types of errors.

To finish with, the process of these occurrences must ensure the required confidentiality.

As mentioned at the beginning of the paragraph, in order to be able to deal in depth with a given occurrence, the formally notified occurrences may not be enough in most cases. It is therefore necessary to be able to meet, to discuss with the persons directly or indirectly involved in the matter.

To do so, the reporting cannot logically be conceived and handed over in a totally anonymous way. The reporting of an occurrence even anonymously enables by crosschecks in most cases to determine the aircraft involved, the date and therefore the persons involved. The error or risks of errors reported by the persons themselves anonymously are likely to become limited with relatively poor contents for fear of being identified. Only would remain the error finding reporting noted by persons not directly involved by such errors, which would mean only to take denunciations into account. This system goes against the objective of transparency to be implemented.

It is therefore important that the persons in charge of the collection and process of these statements ensure their strict confidentiality.
16.4 Occurrence Reporting Process

The safety related incidents, occurrences or errors or potential hazards can be reported from different sources:

- Via operators / customers (occurrence in operation report (Technical flight crew, QRF/QRP, IFSD…reports), reports handed over by the operator from a report by another maintenance organisation),
- Via internal reports of maintenance activities responsible persons,
- Via des internal reporting written by the individuals themselves.

The novelty related to the occurrence reporting processes integrated by Part 145 is to become more especially interested in all the information that can be notified by the personnel themselves.

This system must not be regarded as a means of short-circuiting the existing organisational / managerial structure but before all to reap at the base all the cases of errors enabling to improve the system itself. If significant incidents during the operation or maintenance are known by the management and reported, there are lots of errors or risks of errors that are detected by the technician themselves and that must be reported lest they are not properly analysed and processed.

The reporting involved must be done by the technician having committed the error or by the technician having discovered the error made by another technician (without the latter being aware of having made it) by respecting the confidentiality of data according to the wish of the personnel implied.

| The reporting system should be designed so that it is easy and quick to use for the personnel. It is important, for instance, to avoid asking unnecessary information, too much, using several types of forms. |
| The system should be flexible enough to encourage the individuals to report and hand over the information they have. Different communication supports can be used such as free-text letter, structured paper forms, via computer, via e-mail, via phone, face-to-face. |

If a form can in some case be very useful, it should not by its complexity and the difficulty to fill it in discourage the reporting of occurrences.

The personnel must be trained to the use of this reporting system (theme 10 / HF training) and know the minimum information required to transmit to start an enquiry if necessary.

The error reporting should be reported within a deadline set directly to the person in charge of the whole error reporting system.

16.5 Record of reported occurrences

The record and follow up of the occurrences can be made in different ways.

Some easy systems can enable the record of the main data related to an occurrence such as the date, time, place, brief description of the error, its direct consequences bearing in mind that the other information can remain in text form or different supports recorded in a file.

Other more complex systems can be envisaged enabling the record of coded information and the analysis of their trends (activities involved, contributory factors / causes, associated sectors…).

16.6 Enquiry on the Occurrences.

The system SAGES must encourage the personnel to identify themselves the contributory causes and factors related to a given occurrence bearing in mind that in most cases a more in-depth analysis will be required.
The enquiries must be made by identified persons for this function and trained for that. These persons must ensure the confidentiality of the information got in the frame of these investigations. They can use additional documents and set up interviews with the directly or indirectly involved persons. It can be possible too in some cases to recreate the configuration and to study practically and visually this occurrence according to the possibilities available (reconstitution).

It is clear that a number of reporting related to the occurrences regarded as minor ones or for which the contributory causes / factors are obvious do not require an investigation as such.

Some criteria can also be defined enabling to decide the type of occurrences requiring systematic investigations (QRF, QRP, IFSD, delays of more than 60 min, loss or dysfunction of a primary system of the plane, tool left in the plane, incorrect performance of a task on a flight control noted by production check…). In addition, the organisation will be able to identify the measures that enabled that the occurrence did not degenerate in a more serious incident or measures that were found defective.

The responsibility for the investigation must be officially assigned to one or more persons approved by the organisation. It is advisable that they should report to a senior person of the organisation.

It is important to plan and implement a plan of action associated to the analysis to be carried out and to the interviews to be planned.

Any person having directly or indirectly been implied in a maintenance error or holding information likely to help analysing that error must be able to be freely consulted.

Some tools already exist to set up these investigations, their references are available in the basic documentation (MEDA tools for instance).

The interviews must be carried out in a still place, with discretion, in an atmosphere of peace, without being disturbed at any time.

16.7 Follow-up of the Occurrences

The follow-up of the different occurrences is required to determine the trends (evolutions, diminution) but also to make an overall identification of the part of different contributory causes and factors on the all the occurrences. These items should help in taking priority measures on the organisation of work and training of personnel.

16.8 Corrective Actions

When the risks have been identified (real or potential ones), an assessment of these risks should be made in order to determine the usefulness or not of corrective actions on the matter.

The changes can take different forms (procedures, maintenance data, training, awareness…). The actions must involve the identified causes but also the implementation of items enabling to detect this type of errors before they are made again.

Actions that would be ill-adapted towards a given occurrence (e.g.: punishment of another person) could discourage the personnel from using occurrence reporting systems little by little and therefore be counter-productive ones.

These actions must be relevant and taken quickly to measure their efficiency.
16.9 Information feedback

Information feedback on the analysis, on the actions taken must be made quickly to the persons having reported these occurrences and to all the other persons in order to go on encouraging them to report the occurrences involved.

16.10 Review of the results

A regular review of the issues related to these occurrences and actions undertaken should be organised with the Accountable manager and the responsible persons involved.

16.11 Position of the Authority / internal system

The success of the SAGES system was identified as depending also on a full freedom of investigation of the organisation without fearing punitive actions from the authority.

As a consequence, the French DGAC gives the following assurances:

The French DGAC will not approve the SAGES even if it is included in the MOE. If it is included in the MOE, it will not be audited in a specific way during the supervision of the Part 145 approved organisation.

On another hand, it will be checked that such a system exists and operates. The organisation could for instance show examples of analysis having led to corrective measures effectively implemented or some statistical elements related to the occurrences collected (information provided in an unidentified manner).

The interest in the SAGES system of an organisation only shows a will of collaboration with the finality of improving safety.

The French DGAC will require from no organisation or individual, that they should make available specific reports from this system, other than the information normally handed over to the authority through compulsory occurrence reports.

If an organisation, with a view of improving safety, voluntarily chooses to share with the authority the details or results of its research of a non compulsory specific occurrence, the French DGAC will enforce the same policy than the one defined in the compulsory occurrence reports meeting the European directive 2003/42/CE of June 13th, 2003.

Furthermore, the French DGAC/GSAC commit themselves to:

- not to disclose the name of the person having reported an error shown in a report from the SAGES of the maintenance organisation, or the one of a person also mentioned there. They will not hand over a report from the SAGES system to a third party lest it is required on behalf of Justice or the person involved authorises such a transmission.
- take all the possible reasonable measures in order to avoid disclosing the identity of the reporter or individuals implied in the occurrence, if any action results from a report extracted from the SAGES of the Maintenance organisation must be taken.
- not to launch any disciplinary approach referring the actions or breaks to the rules when information is only reported by the SAGES of the maintenance organisation.

Further more detailed information can be obtained on these issues by reading chapter 4 and appendices A, B and F of the ICAO report doc 9824 and chapter 10 and appendices H, I, J, K, L, M, X of the CAP 716 guide and appendix 3 of the JAA document.
17. ERROR PREVENTION AND DETECTION SYSTEM (145.A.65)

As specified in Part 145.A.65 (b), regarding line and base maintenance of the aircraft, the organisation shall establish procedures to:

- minimise the risk of multiple errors
- capture errors on critical systems
- ensure that no-person is required to carry out and inspect in relation to a maintenance task involving some element of disassembly/reassembly of several components of the same type fitted to more than one system one a same aircraft during a particular maintenance check. (Avoid that all the systems ensuring the same function show a failure following to an error of execution)

The notions seen in the former chapters are actions enabling to avoid or limit the quantity or the importance of errors. Adopting a procedure, a work card, improving working conditions, communication among the different actors and making aware through training the technicians to human factors are approaches that prevent errors.

This chapter deals with the case of:

- errors that might happen all the same and that can be detected by additional controls (error detection).
- errors on critical systems that might not be detected before the following flight (error tolerance)

These notions of error detection or error tolerance are different from the « uphill » notion enabling to lower the risks of errors related to processes/means/resources/organisation.

17.1 Error Detection

The first case refers to errors that could be generated in the frame of works on error critical and vulnerable systems than can therefore have a major impact on the airworthiness of the aircraft.

Error capture is a major element in the area of safety. There are different types of systems enabling to meet this need, that is to say:

- Functional, operational tests,
- Independent duplicated inspections,
- Visual checks (e.g.: leaks),
- Inspections of the task by someone else during the fulfilment and before signing off the task themselves,

This system meets a production control function.

17.1.1 Functional / Operational Tests

Functional tests are error detection mechanisms that can enable if they are correctly carried out, to detect that a component was not installed or was not properly installed or was not properly adjusted or does not work according to the parameters specified in maintenance data.

It is important to pay special attention to these functional tests that must be properly carried out in order to check accurately what must be checked and record all the associated data.

The flight crew pre-flight check does not necessarily cover all the possible cases, an undetected error in the frame of a functional test can have direct operational consequences.
17.1.2 Duplicate Checks

« Duplicate checks » refer to a task carried out by one person and checked by the same person (if qualified to do so) followed by another independent check performed by another person. In both cases, the checks involved must be exhaustive and must include, if applicable, functional tests.

The skills or confidence towards the first technician having performed the check must not be taken into account in the execution of the second check.

This second check must be performed as soon as possible after the first check. It is on another hand required to record the two dates of performance of these checks. The records following these checks must not be limited to « done » or «Nothing To Declare» but to record relevant information on the matter.

To determine the tasks justifying the launching of duplicate inspections, it is important to take the following points into account:

- The critical aspect of the tasks and the consequences of an error on the system involved,
- The vulnerability of the task towards risks of errors (taking into account former incidents, already reported errors on the subject, a risk study...)
- Whether there are or not other inspections (functional tests.)

As specified in the AMC of Part 145, the basic tasks for which this control notion is required are:

- The installation, adjustment, rigging of flight controls,
- Engine installation,
- Overhauls, adjustment of assemblies (engines, transmission, engine gearboxes)
- Intervention on emergency systems.

On another hand, it is important to avoid « overusing » this type of duplicate inspections. This situation could have contrary consequences to those sought. They can bring a lack of responsibility of the technicians carrying out the tasks themselves because of additional systematic inspections. It is therefore required that these duplicate inspections are limited to the strict necessary.

Regarding these checks, it is important to record the observations when these checks are not satisfactory and that the task must be done again. This information should logically be the object of an occurrence report so that an analysis of this task can be analysed if necessary and that the required actions are taken.

17.2 Critical Systems

The second case to be taken into account is the system enabling to avoid that a same error related to carrying out identical tasks on different systems brings a bad operation of the systems involved.

This must before all enable to avoid identical errors to be repeated on identical systems of an aircraft that might have catastrophic consequences and not only to detect errors.

This system refers especially to the launching, planning of the tasks and allocation of the tasks to different persons.

Some elements developed in this chapter could be presented in the procedure of chapter 2.18 of the MOE

Further more detailed information can be obtained on these issues by reading chapter 4 and its appendix A of the ICAO report doc 9824 and chapter 3 of the CAP 716 guide.
APPENDIX II

IMPLEMENTATION PLAN
OF THE MAINTENANCE SAFETY SYSTEM AND HUMAN FACTORS APPROACH

0. INTRODUCTION

The aim of this implementation guide is to help the organisations in identifying the main tasks related to the implementation of the Maintenance Safety system and human factors approach.

1. PREPARATION OF THE LAUNCHING OF THE APPROACH

The first step is to convince the different managers of the company, the personnel and the trade unions of the interest of this approach.

If the human factors / safety notions are made necessary by the ICAO and EASA requirements, rising awareness on the true reasons associated to this approach (incidents/accidents). Do not forget to present the means to be planned to implement and maintain the system involved.

2. COMMITMENT OF THE MANAGEMENT

When the support of the management is acquired, it is important that the Management should write a document describing its commitment towards this Safety/HF approach and that this commitment should be discussed with the representative bodies and the personnel before a widened publication (letter, magazine ...).

3. TRAINING OF THE PERSONNEL IN CHARGE OF THE IMPLEMENTATION OF THE SAFETY SYSTEM AND HF APPROACH

First, all the persons directly involved in this file (HF manager, HF coordinator....) should be trained including the HF instructors themselves.

As a whole, the use of external training is required in most cases.
4. **ANALYSIS OF THE SITUATION OF THE COMPANY IN THE MATTER**

Lead a general study on the culture, procedures, systems and work practices. This study must refer to all the maintenance activities including engineering and logistics.
This study can be carried out via questionnaires, interviews, work meetings, audits centred on the human factors / working conditions aspects…

5. **COMMUNICATION OF THE RESULTS OF THIS STUDY.**

This communication will strengthen the need of the implementation of the human factors / safety approach. This communication should not be limited to the management and should involve the whole personnel.

6. **IMPLEMENTATION OF THE STRUCTURE AND APPOINTMENT OF THE RESPONSIBLE PERSONS**

It is not required in Part 145 to anticipate a Maintenance Safety System manager within each organisation.
Nevertheless, the analysis of the responsibilities, the functions to be ensured, the need of enough independence and legitimacy quickly leads to the conclusion that it is in some case logical to anticipate a Safety manager.
This responsibility can be assumed by the Quality manager provided he/she is available enough.
It is not necessarily required to implement a full time Human Factors manager. On another hand, it is advised, to have at least a human factors project manager who will be there at short notice to deal with all the issues.

7. **IMPLEMENTATION OF THE REQUIRED MEANS / RESOURCES.**

It is important to assess the new workloads associated to human factors / Safety. If logically, the activities of implementation of the human factors related measures can at short term be time consuming, it is clear that at medium term the most significant and continuous workloads will regard initial/continuous human factors trainings and the management, record, investigations related to the errors and follow up of the occurrences.

8. **TRAINING OF THE MANAGEMENT AND PERSONNEL IN CHARGE OF THE IMPLEMENTATION OF INITIAL MEASURES RELATED TO SAFETY AND HF**

This training is meant before all to the personnel of the organisation that must directly intervene in the implementation of the Safety policy and the implementation of the human factors approach associated measures (e.g. : methods, preparations, productions manager…).

9. **MEASURE OF THE COMPETENCE OF THE WHOLE PERSONNEL ON THE ISSUE AND TRAINING REQUIREMENTS.**

This point is very linked to already taken actions on the issue by the past, the culture of the company and other criteria.
Leading an analysis of the training needs in order to determine the required training and training level for the different categories of personnel.
10. IMPLEMENTATION OF INITIAL MEASURES RELATED TO SAFETY AND HF

Development of an action plan. This plan should specify the actual measures to be taken in the organisation, the means, infrastructures, work documents, persons responsible for these changes and the deadlines and checks of the measures taken. These measures should especially include the implementation of an error detection/ reporting/ analysis and process system and the other basic measures related to human factors towards environment, data and procedures.

11. ORGANISATION AND CARRYING OUT TRAINING OF ALL THE PERSONNEL INVOLVED IN HF

The training planning should be organised according to the determined training priorities and may cover the period up till September 28th, 2006.
This training regards all the other persons not yet trained such as mechanics, preparation agents, logisticians, technical agents…

12. FOLLOW-UP AND CHECK OF THE ACTIONS UNDERTAKEN

At this stage, the system must be regarded as operating, the approach enforced.

This approach must be regularly reviewed and assessed to check that there are enough resources and that the deadlines are properly met.

In order to check the introduction of human factors within the organisation, briefing must be made regularly on the issue.
Regular audits and the results of the reported incidents / occurrences must be the most important items of this control system.

Indicators can be implemented. Caution: the increase in the number of reported occurrences at first must be positively analysed because it will be the demonstration of the enforcement of a safety culture in the company.

13. REGULAR COMMUNICATION ON THE ADVANCE OF THE APPROACH

Communication of the measures taken / to be taken at term for all the personnel.
APPENDIX III

ERROR GLOSSARY AND EXAMPLE OF THE HELP SYSTEM TO DETERMINE THE LEVEL OF RESPONSIBILITY IN CASE OF SIGNIFICANT ERRORS.

GLOSSARY

**Human error**: Failure of planned action to reach a fixed aim.

**Error of execution** – *(slips) / (lapses)* :

The intention is correct but followed by an incorrect action.
Often described as a careless error, it is characteristic of well-trained persons, operating out of habit, in known environments.

There are two types of them:
- Those directly notable and commonly associated to inattention or perception errors, « slips ».
- Those originated inside the individual and that often come from memory problems, « lapses ».

**Error of intention** – *(Mistakes)* :
Error in the elaboration or intention after a bad diagnosis or by lack of knowledge.

They come from two categories:
- Those resulting from the bad or non-enforcement of an appropriate rule.
- Those that result of the implementation of actions out of the scope of a referential of competence of the individual and that it is necessary to conceive and develop in real time.

**Violation** :
Action of voluntarily breaking a rule, a law, a procedure.

They come from three categories:
- Routine violations where rules are usually broken.
- Exceptional violations where rules are broken in an arbitrary and random way.
- Violations for maximisation where the rules are inadvertently transposed in a care of maximisation.
Example of help system for the determination of the level of responsibility in case of significant errors.

(1) Test of substitution

The diagram above introduces the test of substitution whose principle is the acknowledgement that even the best ones can commit the worst errors.

During a case analysis implying special persons having committed significant errors, it is convenient to make the following mental test:

To the individual involved substitute a person having the same scope of activity and having comparable qualifications and experiences. It is then convenient to ask the following question: « at the light of the development of the occurrences their perception by the persons implied in real time, is it possible that this other individual did behave differently? »
If the answer is « probably no », the level of implication of the person involved is low…

A useful complement of the substitution test is to ask the peers of the individual the following question: « Taking into account the circumstances under which the occurrence happened, could you be positive that you should not have made the same error or a similar one? »
If the answer is « probably not » then in the same way, the level of implication of the person involved is low.