HELICOPTER MAINTENANCE TOOLKIT

European Helicopter Safety Team

1st Edition

ACKNOWLEDGEMENTS

Many people on both the European Helicopter Safety Team and the International Safety Team contributed to this tool kit. However, I would like to take this opportunity to publicly thank the following individuals who went "above and beyond" to provide an excellent reference for the worldwide helicopter community. These are:

INTRODUCTION

The people who maintain aircraft in a safe and airworthy condition are the backbone of aviation. And, they have done so since the dawn of aviation. As John Goglia, a career Airframe and Powerplant mechanic and former Member of the US National Transportation Safety Board, is fond of reminding us, the first pilots, the Wright brothers, were mechanics first.

The Maintenance Tool Kit is intended to provide helicopter operators with a framework of guidance material to ensure that they can safely maintain their aircraft in airworthy readiness for operations in the most cost-effective manner possible. No matter what size company or how many helicopters are involved, it is essential for all the stakeholders, including the owners, operators and their customers, to agree on how maintenance is to be done and to document that agreement to assure a shared understanding and consistent execution.

This tool kit is designed to complement the other tool kits generated by the International Helicopter Safety Team (IHST). These are located on the IHST website (www.ihst.org). They include the Safety Management System (SMS) Tool Kit, Training Tool Kit, Risk Assessment Tool and the Helicopter Flight Data Monitoring Tool Kit. The safety principles described in the SMS Tool Kit are, among other proven practices, the foundation for the maintenance principles of this toolkit and the relevant practices described in that tool kit will be referenced, but not replicated herein.

The European Helicopter Safety Team (EHEST) analyzed 311 accidents during the period beginning in 2000 and ending with 2005. In those accidents, maintenance was identified in 14% of the events. The IHST's Joint Helicopter Safety Analysis Team (JHSAT), based in North America, conducted a similar effort. In their study of accidents occurring in the year 2000, 24% of the accidents identified maintenance as a causal factor. Subsequent study of accidents that occurred in 2001 found 19% involved maintenance.

In addition, one of the other accident causation categories is entitled Parts and Systems Failure. The IHST 2000 study identified poor maintenance practices as the cause in 86% of these. The primary issue was failure to follow approved instructions for continued airworthiness; i.e., failure to follow procedures. The point is that maintenance activities, or lack thereof, play a significant role in accident causation and we need to find ways to prevent those from happening.

To that end, the EHEST team also identified over 100 intervention recommendations (IRs). The IRs are actions which, had they been implemented, could have either reduced the probability or severity of the event or prevented it altogether.

The EHEST IRs were consolidated into broad categories. These included:
- Strict adherence to Instructions for Continued Airworthiness
- Confirmation of Compliance (Quality Control or QC, qualified co-worker)
- Company support (SMS, training, Quality Assurance (QA), tech pubs, engineering)

- Training and competence assurance of technicians
- More complete original equipment manufacturer (OEM) information
- Civil aviation authority (CAA) oversight

The IHST findings, including the IRs, were nearly the same. They identified some additional prevention recommendations. These included:
- Use of approved parts
- Health and usage monitoring systems (HUMS)

The Maintenance Tool Kit is offered as a resource for maintenance technicians everywhere and anywhere. The format is a skeletal reflection of what is known in some regions of the world as a maintenance organisation exposition. The intent of this tool kit is for helicopter operators to assess their existing maintenance activities against these guidelines. Chapter 1 addresses the purpose of the helicopter operator's maintenance organisation, its scope of work, key roles and responsibilities, key policies (e.g. quality and safety) and resource requirements. The remaining chapters give guidelines for maintenance procedures, quality assurance, training and competence assurance, record keeping, HUMS, maintenance support equipment and fuel systems.

This Maintenance Tool Kit refers to external documents that provide more detailed reference material that may be applicable for various guidelines suggested in this document.

It is not the intention of the toolkit to replace, supersede or counter the regulations applicable to the operator but to show best practice used by many operators throughout the world. Many items of best practices are taken from authority regulations such as EASA and the FAA. Others are taken from the Oil & Gas Producers (OGP) standards and individual helicopter operators and major clients of helicopter operators. It is important to note that the operator's relevant Authorities regulations must take precedence over the guidelines in this toolkit and where there is potential for any conflict the relevant National or Regional Authority requirements must be upheld and followed.

The toolkit has been developed primarily in a bullet point format to allow helicopter operators to use as a checklist. It is important to note that the toolkit is written as a "what" to do and not a prescriptive "how" to do. The operator can decide how the maintenance checklist guidelines can be implemented in it's own organisation. This Toolkit offers broadly accepted best practices for helicopter maintenance. While in many cases these best practices described in this Toolkit may exceed regulatory requirements, operators remain responsible for ensuring that all applicable civil aviation authority's requirements are met.

If you have any comments or suggestions, please contact:
Mr. David Huntzinger, EHEST Co-Chair at david.huntzinger@eurocopter.com

TABLE OF CONTENTS

CHAPTER 1

MAINTENANCE MANAGEMENT

1.1 Leadership Commitment

The Accountable Manager has authority for ensuring that all maintenance required can be financed and carried out to the standard and requirements of the National or Regional Authorities and the company maintenance exposition document.

1.2 Safety Policy

The Safety Policy is the company's internal and external declaration that safety is the organisation's first priority. It reflects the safety philosophy, policy direction and commitment of top management to a safe operation.

The safety policy is the basis for establishing and executing the Safety Management System (SMS) and for compliance with aviation laws, regulations and procedures. All company regulations, procedures and manuals should flow from this Safety Policy.

The Safety Manager should periodically review the Safety Policy so that it reflects the Company's internal and external policies and any changes to the organisation, operation or environment.

The Safety Policy is approved and signed by the person with overall accountability for the entire business; e.g., the Chief Executive Officer.

1.3 Management Personnel Roles & Responsibilities

A company should have sufficient maintenance management personnel commensurate with the size and the scope of work of the company.

1.3.1 Accountable Manager

The Accountable Manager is responsible to the company owners or board and the National or Regional Authorities for the following:

- Ensuring that all necessary resources are available to accomplish maintenance in accordance with the operator's civil aviation authority approval & the company Maintenance Exposition.
- Establishing and promoting the safety and quality policy specified by the civil aviation authority.
- Ensuring the risks of the maintenance activities are identified and managed to acceptable levels of safety

1.4 Maintenance Management Personnel

The size of and scope of work of a company will dictate the number and roles of the maintenance management and supervisory positions. Typically a large organisation, operating four or more helicopters, would expect experienced staff covering the following positions. In small organisations, it may be necessary for one person to cover more than one of the recommended positions. In such cases, the company will need to demonstrate that the key responsibilities are managed and covered adequately.

1.4.1 Chief Engineer or Maintenance Director (Designated Post Holder)
There should also be a designated:
- Deputy Chief Engineer
- Shift Supervisor

1.4.2 Continuous Airworthiness Manager (Designated Post Holder)
There should also be a designated:
- Deputy Continuous Airworthiness Manager

1.4.3 Quality Manager
There should also be a designated:
- Quality Auditor

1.4.4 Stores Manager or Supplies Manager

1.5 Duties & Responsibilities of Maintenance Management Personnel

1.5.1 Chief Engineer or Maintenance Director
The Chief Engineer (or Maintenance Director) is responsible for the following:
- Providing leadership to the maintenance team
- Planning the day to day management of maintenance activities
- Allocating sufficient trained and experienced technical staff for the required maintenance activities
- Ensuring the required manuals, paperwork, tools and spares are available to execute the work
- Liaising with the flight operations department for sufficient access to the helicopters to carry out the work
- Long term maintenance planning together with the flight operations department to ensure that both maintenance & flight operations requirements are satisfactorily met and that sufficient manpower is available to meet the plans
- Custodian of the maintenance SMS responsibilities
- Management of deferred defects
- Technician training program including recurrent training
- Attending maintenance management review meetings
- Liaising with the Civil Aviation Authority
- Currency of the company Maintenance Manual

1.5.2 Continuing Airworthiness Manager

The Continuing Airworthiness Manager is responsible for the   following:

- Development and control of the maintenance program
- Management and approval of modifications or repairs
- Ensuring that all applicable Airworthiness Directives (ADs) are embodied
- Ensuring that all optional Service Bulletins (SBs) are reviewed for compliance and that records are kept of decisions and actions taken
- Ensuring that all defects discovered during maintenance are satisfactorily corrected
- Coordinating scheduled maintenance, embodiment of ADs, replacement of service life limited parts and component inspection requirements
- Interfacing with third party companies carrying out maintenance, repair of modification activities for the company
- Management of the Technical Records
- Managing component reliability program
- Managing repetitive defect program
- Management of the Technical Library
- Attending maintenance management review meetings
- Liaising with the Civil Aviation Authority
- Currency of the Continuing Airworthiness Manual
- Weight and Balance data control
- HUMS
- Aircraft certification, Certificate of Airworthiness, Export Certificate of Airworthiness, Permit to Fly
- Complex task stage worksheets (identification compilation and control)

1.5.3 Quality Manager

See Section 6.2

1.5.4 Stores Manager

The Stores Manager is responsible for the following:

- Ensuring all incoming parts have the correct approval paperwork
- That all incoming items are checked against the purchase order for correctness
- Establishing stock management standards
- Issue controls and process for parts being drawn from the stores
- Ordering replacement stock and urgently required parts whilst maintaining effective cost controls
- Stock checks
- Control of shelf life items
- Control of tools including calibrations
- Segregation of spares

1.6 Training Policy

The company must ensure that the technical staffs have received the following training:

- Helicopter type training for helicopter(s) operated
- Human factors
- Introduction to SMS
- Induction training for new employees
- Any specific training, e.g. HUMS, Fuel Quality Control
- Auditor training for QA staff
- Periodic recurrent training

1.7 Facilities & Support Equipment

- Description, layout and size of the hangar and associated equipment
- Description, layout, size and capability of the operator's workshops
- Description, layout and size of the store
- Description and layout of the technical offices and facilities
- Provision of facilities, equipment and tooling appropriate to the needs and scope of the maintenance capability

1.8 Scope of Work

- The operator should have an approved capability list for all their bases
- The operator should have a list of the various sub-contractors they use for component repair and overhaul including details of the subcontractor's approvals

CHAPTER 2

MAINTENANCE

2.1 Maintenance Procedures

The company should have written maintenance procedures held in a controlled document such as a company Maintenance Manual or Maintenance Organisation Exposition. The document should include the following procedures:

- The use of the Flight & Technical Log/Journey Log
- Control of Deferred Defects
- Recording and clearing helicopter defects
- Tagging of helicopter parts, serviceable, unserviceable and quarantined
- The use and control of additional maintenance worksheets
- The use of stage worksheets for major component changes
- Helicopter release to service, post maintenance
- Requirement for Duplicate Inspections/Required Inspection Items (RII) for critical components
- Details of the company defined critical components
- Extending servicing, maintenance and component time between overhauls (TBOs) as appropriate
- Monitoring and managing repetitive defects
- Monitoring and managing component reliability
- Review, implementation, control and recording of ADs
- Management of optional SBs
- Management and use of HUMS
- Airframe repairs
- Use and control of specialized tools and ground equipment including any calibration or testing
- Tool control
- Hangar maintenance
- Line maintenance
- Towing and aircraft maneuvering
- Maintenance Error Management (MEM) investigation and review
- Service Difficulty Reporting (SDR)
- To highlight any incorrect information given in the maintenance manuals to the helicopter manufacturer
- Weight and balance requirements
- Housekeeping and cleanliness of the maintenance facility, workshops and associated facilities
- Technical occurrence reporting
- Shift planning and minimum staffing levels
- Fatigue management, including minimum rest period requirements
- Drug and alcohol policy

The Company Maintenance Manual or Maintenance Organisation Exposition should be reviewed periodically to ensure that it is kept up to date and relevant to the latest requirements and company activities.

2.2 Health & Usage Monitoring Systems (HUMS)

HUMS is a valuable tool that if used correctly can give the helicopter operator useful information to help keep the helicopter airworthy. To get the best benefits from HUMS the following processes should be followed:

- A HUMS download must be taken at least at the end of each day's flying.
- Technical staff on site must be trained to analyze the daily download to ensure the following:
- There have been no exceedances since the last download
- That all parts of the HUMS are serviceable.
- That any items being closely monitored have not deteriorated outside any proscribed limits.
- There is provision to send the download to a specialist to assist in evaluating the HUMS data as necessary before the next flight.
- The HUMS including the ground station should be covered by the Minimum Equipment List (MEL) or similar.
- The operator should have an arrangement in place with the helicopter/HUMS manufacturers for threshold management of the HUMS software.

CHAPTER 3

MAINTENANCE ADMINISTRATION & DOCUMENTATION

3.1   Technical Records

The helicopter technical records should be recorded on an off-the-shelf Technical Records database, or a locally developed database, or paper records.

Whichever method is used, the following should be recorded in the helicopter technical records:

- Scheduling maintenance requirements (Due List).
- Scheduling component changes (Due List).
- Scheduling repetitive AD or SB requirements (Due List).
- Listing the complete individual helicopter component inventory.
- Listing the AD status.
- Listing the SB status.
- Producing a monthly planned due list.
- Recording and managing deferred defects.
- Recording work carried out including component changes, modifications and repairs.

Whichever method of holding records, a back up record must be kept (normally in a fireproof container or offsite storage) and the Technical Records Manager must have a method of self audit to ensure the record keeping is correct.

Helicopter records should be updated at least weekly with the following:

- Helicopter flight hours
- Helicopter landings
- Helicopter cycles if appropriate
- Engine hours
- Engine cycles

All serialized helicopter components must be tracked and controlled as appropriate by the following:

- Time Since New (TSN)
- Time Between Overhaul (TBO)
- Service Life Limit (SLL)
- Flying hours
- Cycles
- Landings
- Calendar

Maintenance checks should be highlighted as required by flying hours, cycles or calendar as appropriate.   All aircraft records must be retained and archived in accordance with the requirements of the relevant National or Regional Authorities.

3.2   Flight & Technical Log (Journey Log)

The Flight & Technical Log (FTL) is an important link between the technical department and the pilots. The log should clearly show the status of the helicopter and highlight to the pilot any requirements or feedback required post the flight. In particular the Flight & Technical log should have provision for the following:

- The total of flight hours, cycles & landings
- The recording of individual flight details
- The total of the day's flight details and grand totals to be carried forward
- The pages of the FTL should be number indexed
- The date
- The pilot(s) names and the helicopter acceptance signature
- Technical department pre & post flight inspection signature as required
- The details of the next planned maintenance
- Details of any MEL deferred items
- Space for the technical department to list flight test requirements
- Space for the pilot to enter defects post flights, or enter positively "Nil defects"
- Space for recording husbandry or non airworthy issues
- Records of engine power assurance checks
- Fuel uplift

3.3   Deferred Defect Log/No Go MEL Items

The Deferred Defect (DD) log should have the following:

- Details of the defect.
- The signature of certifying technician entering the defect plus the date.
- Date of when the DD must be rectified.
- The DD log pages should indexed.
- A space to enter the MEL reference.
- A space to record the FTL page number when the defect was entered in the FTL.
- Provision to record the FTL or worksheet reference when the defect is rectified.
- Reference to the replacement parts ordered (order number).

3.4   Maintenance Planning

The company should use the following documents for maintenance planning:

- An approved helicopter maintenance schedule
- Manpower/maintenance requirement plans
- Maintenance review/planning meetings
- Component replacement requirements
- AD and SB listings from OEMs and Regulators (National or Regional Authorities)
- Modification embodiment plans
- Airframe repair requirements
- Helicopter operational usage forecast
- Special tooling requirements

3.5   Technical Library

The Technical Library is responsible for the following:

- That all the required maintenance manuals for the helicopter types and associated equipment are available for use at the appropriate base.
- That all manuals are at the correct amendment status in accordance with the helicopter manufacturer's information.
- That a process is in place to ensure prompt receipt of all manual amendments and technical information from the helicopter manufacturer.
- That a process is in place to distribute issued amendments promptly and ensure manuals are updated.
- Have a process in place to ensure prompt receipt of ADs for the helicopters that it operates.
- That only controlled manuals are available for use and old or uncontrolled manuals are marked accordingly or destroyed.

CHAPTER 4

HELICOPTER PARTS STORE

4.1   Store Attributes

The aircraft store should be a secure location with restricted access other than staff responsible for managing and operating the store.

The store should be large enough to hold all spare parts with stock held in identified locations, or in the case of large components specified secure locations.

Items in the store should held in either bins, racks, cupboards or stands as appropriate to the storage needs of the item; each with a location index to allow quick location.

The aircraft spare parts store should be in a clean, well ventilated and maintained, at a constant temperature to minimize the effects of condensation.

4.2   Store Management and Control

The management and control of the helicopter spare parts store should be recorded in a controlled stores manual. The manual should cover the following:

- Description and layout of the store
- List of approved suppliers
- Process of supplier evaluation and audit process
- Process for ordering helicopter spares
- Process for the receipt and inspection of incoming spares
- A batch number or similar to allow any component to be traced to its original supplier or manufacturer
- Process for dispatching unserviceable spare parts for repair or overhaul
- Process for scrapping components once past their shelf life or parts beyond economical repair
- Process for tagging, serviceable parts, unserviceable parts and quarantined parts
- Process for issuing components to technicians
- Process for tracking shelf life items held in the store
- List of staff that has access to the store
- Control of special tools
- Calibration of tools and equipment as required
- Use of stores database or card system for logging individual parts
- The process and periodicity of stock checks
- A process for receipt of parts back into the store if removed serviceable from the helicopter or were unused after issue

4.3   Dedicated Areas

The store should be divided up into the following dedicated areas:

- Receipt items.
- Items for dispatch.
- Unserviceable items awaiting a decision on their future.
- A secure location for quarantined items.
- Serviceable parts.

In addition toxic or flammable items should be stored in a safe area separate to the main stores area but still under the control of the stores department. It is however acceptable to have small amounts of ready use flammable items as oils and greases in the main store in a flame proof locker.

CHAPTER 5

LINE MAINTENANCE & FUEL QUALITY CONTROL

Line maintenance and operations should be covered in the company Maintenance Manual or Maintenance Organisation Exposition or a dedicated controlled company line maintenance manual. The manual should include the following:

- Procedures for line maintenance activities.
- List of approved line maintenance activities.
- Helicopter ground handling procedures including starting and shutting down helicopters.
- Training requirements for personnel ground handling helicopters.
- Passenger handling procedures.
- Daily helicopter fuel water drain test procedures.
- Refuelling procedures.
- In situations where the organisation has its own bulk fuel facility, detailed procedure for the management and quality control of the facility and fuel stocks.
- Required line fire fighting equipment.
- Procedures for managing loose articles on the line to prevent foreign object damage (FOD).

CHAPTER 6

QUALITY ASSURANCE

The Maintenance Quality Assurance department should be managed by a company employee who is dedicated to Quality Assurance, or in the case of a small operator with limited number of staff there should be an employee with dedicated time allocated to Quality Assurance duties in addition to his or her other responsibilities. In the case that the Quality Manager has other duties, he or she should not be auditing any areas for which they are directly responsible.

Alternatively it is acceptable for a company to contract in, on a part time basis, a trained and approved Quality Manager.

The Maintenance Quality Assurance department could be part of the company Quality Assurance organisation that is responsible for Quality Assurance throughout the company.

6.1 Quality Policy:

The company should have a written Quality Assurance Policy and a controlled Quality Assurance Manual to include the following:

- A description of the quality system
- The duties and responsibilities of the Quality Manager
- The training requirements for the quality auditors
- The generic audit plan
- Process for amending the planned audit program
- The management of audit findings including:
  - The recording of findings
  - The classification of findings; high, medium or low or similar
  - The addressing of findings (e.g., corrective actions)
  - The follow up and close-out of audit findings
  - Assessment of the effectiveness of audit close out actions
- Compliance monitoring process for technical staff
- Product audit process
- The audit of any third parties
- Process where applicable for the extension of maintenance checks and component overhaul life

6.2 Responsibilities of the Quality Manager:

- Managing the Quality Assurance department.
- Providing oversight of the maintenance organisation.
- The currency of the Quality Manual.
- Developing the technical department audit program
- Planning, implementation and managing the audit program
- Training program including Human Factors and SMS training for the quality auditors
- Auditing of out stations
- Auditing of third parties as required
- Managing audit findings
- Managing any Quality Assurance database

- Overseeing the Compliance Monitoring program
- Liaising with the Civil Aviation Authority
- Operating the company certifying staff approval process
- Developing Quality Assurance department statistics
- Informing the Accountable Manager of the status of the quality system and auditing findings
- Managing maintenance occurrence & maintenance error reports and investigations
- Control and management of maintenance check and component overhaul life extensions
- Attending maintenance management review meetings
- Control of approved suppliers list

6.3   Technical Department Quality Audit Program:
- The annual audit program should cover all the technical areas of the company.
- Audits should cover the working periods of the company particularly night and weekend work, where appropriate.
- Product audits should be part of the audit plan.

6.4   Quality Auditors training:
- Quality auditors should have received a formal auditor training course
- One auditor minimum should have done Lead Auditor training
- Quality auditors should have received Human Factors training
- Quality auditors should have received SMS awareness training
- Quality auditors should receive periodic recurrent training

6.5   Quality Assurance Administration Control
The audit program, audit findings and audit follow up should be managed by either software or paper manual system. Ideally if software is used the software should be able to manage the findings of both the SMS and the Quality System.

Whichever system is used to control the Quality Assurance, the following should be managed:
- The internal audit program
- External audit program including client audits
- All audit findings
- The audit finding classification and risk assessment
- Findings follow up (e.g., corrective actions)
- Findings close out
- Effectiveness of the audit program and the highlighting of and trends, positive or negative with audit findings
- Quality audit statistics.

6.6   Compliance Monitoring Program

In large organisations and whenever practicable in smaller organisations, each maintenance technician should periodically (at least annually) be observed during a maintenance task by an independent person who is competent to assess whether the technician observed:

- Has the appropriate tools and workspace
- Has the appropriate training for the assigned task
- Uses the appropriate procedures; e.g., with reference to required technical documents and the company's Maintenance Manual or Maintenance Organisation Exposition

The lessons learned from observation of maintenance tasks should be fed back into maintenance training and the maintenance procedures (e.g., Maintenance Manual or Maintenance Organisation Exposition) to promote continuous improvement.

CHAPTER 7

REFERENCES

The toolkit has been developed using best practiced observed by many good helicopter operators from throughout all parts of the world by the toolkit developer. The references listed below are some of many excellent documents available that may be used by operators when deciding how to develop or introduce systems listed in the toolkit.

- EASA Continuous Airworthiness Maintenance Organisation (CAMO), Part M subpart G

- EASA Part 145 Maintenance Organisations Approval, and its Technical Handbook
  http://easa.europa.eu/rulemaking/technical-publications.php

- EASA Part M Continuing Airworthiness Requirements, and its Technical Handbook
  http://easa.europa.eu/rulemaking/technical-publications.php

- FAA Part 43 Maintenance, Preventive Maintenance, Rebuilding and Alteration

- FAA Part 121, § 121.373 and Part 135, § 135.431defining a Continuing Analysis and Surveillance System (CASS)

- FAA AC No 120-79A Developing and Implementing an Air Carrier Continuing Analysis and Surveillance System

- FAA AC 120-16, Air Carrier Maintenance Programs

- FAA Aircraft Maintenance Human Factors web portal:
  https://hfskyway.faa.gov/hfskyway/

- FAA Safety Team web portal:
  http://www.faasafety.gov/

- International Oil & Gas Producers Aircraft Management Guidelines
  www.ogp.org.uk/pubs/390.pdf

- SKYbrary Human Factors web portal:
  http://www.skybrary.aero/index.php/Portal:Human_Factors

- UK CAA CAP 716 Aviation Maintenance Human Factors (EASA Part-145)
  http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=275

- UK Royal Aeronautical Society (RAeS) Maintenance Engineering Standing Group - Maintenance Human Factors Reports.
  http://www.raes-hfg.com/maint-sg-reports.htm

- UK CAA CAP 753 Helicopter Vibration Health Monitoring
  http://www.caa.co.uk/docs/33/CAP753.pdf