Maintenance Briefing Notes

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Maintenance Documentation

Introduction

The daily work life in the maintenance environment is almost entirely dominated by written procedures. There is a procedure for every scheduled task to be done on the aircraft.

Following procedures is a pre-requisite for safety and error avoidance.

Nevertheless, evidence shows that non-adherence to, or mis-interpretation of procedures, is often the direct or in-direct cause of events related to maintenance operations.

More complex aircraft structure and systems design may, at first glance, lead to less obvious failure modes than on older generation aircraft types.

This in turn makes it imperative that manuals and procedures must be designed to minimise the room for error.

Maintenance documentations in this context includes manufacturers' documentation, customized job instruction cards, and documentation issued by the regulators.

We will see in this Maintenance Briefing Notes that the failure to follow procedures, is an important contributor to incidents, or even accidents.

This being the result of post-event investigation and industry research performed on this field as referenced further below.

The issues related to maintenance documentation are complex, ranging from the way the procedures are written, how they are used and available within the organisation, up to individual behaviours.

An Engine Change

The following case study describes an observation of an actual work team performing an engine change. The observers were particularly interested in the extent to which maintenance documentation was used, and how helpful it was. The engine change observation was one part of a broader maintenance human factors research study performed in the frame of the ADAMS research program by the Trinity College, Dublin.[1)]

Case study:

One of the first steps in the AMM procedure is to open the access door below the cockpit in order to enter the avionics compartment and to pull 58 circuit breakers (C/B).

The circuit breaker list was preceded by a warning note: "Open circuit breakers ABC1(2) and DEF1(2) before you open circuit breaker XYZ1(2). If not, the LP fuel valve will open and there is a risk that fuel will flow out".

What happened during this engine change was that the LP fuel valve did open with the resulting fuel spillage!

The research team investigated in which way this procedure in the AMM was displayed.

It appeared that the warning note was on one page, and then the page had to be turned to the next page with the list of circuit breakers to be pulled.

The listed order of sequence of the 58 circuit breakers in the AMM, was the one equivalent to the order of which the circuit breakers were installed on the C/B panel, and not in the order of which they had to be pulled in line with the instructions of the warning note.

The warning note in the AMM was noticed by the performing work team, but not followed in the consecutive work steps as instructed by the warning note.

A simple and yet less than obvious lesson learned is to avoid random page breaks in a document. A task as simple as this can make a difference in error rates. The concept is that there should be a minimum need for page turning at critical points in a procedure.

When the written instructions are on one page (the warning note in our case study), and the associated diagram on the next page (the list of C/B's), this puts unnecessary load on "working memory" and can lead to errors.

Today, aircraft manufacturers publish maintenance documentation in digital format, and the page break, which appears on paper documents, is not a common problem anymore.

However, attention should be given when the instructions are printed, or transformed into customized documents.

The general consensus from this engine change observation (as part of the ADAMS project) was that the manuals were consulted most often for facts, for example torque values, rather than techniques.

The importance of Maintenance Documentation

In 2004, the UK Flight Safety Committee determined that the top three causes of maintenance mishaps were:[2)]

- Failure to follow published technical data or local instructions
- Using an unauthorized procedure not referenced in the technical data
- Supervisory personnel accepting non-use of technical data or failure to follow maintenance instructions

The failure to use documentation is a leading contributor to maintenance events. In most cases organizational issues resulted in failure to use documentation that was available.

The reasons why procedures are not followed

The ADAMS study revealed that evidence shows that aircraft technicians reported not following task procedures according to the maintenance manual, in over one third of tasks accomplished.

Technicians said that there are easier and quicker ways than the official method. Those who have consulted the manuals but do not follow the official method, reported that:

- Task card or the steps to complete the task were unclear
- Task involved guesswork or trial and error
- Aircraft maintenance history would have been useful but was unavailable
- Not all of the procedures are necessary, but have evolved over time as a reaction to specific incidents
- If they followed maintenance manual to the letter this would inevitably slow down their progress and make it difficult to meet deadlines as most procedures are either too simple or too detailed
- Following procedures on routine tasks is not an efficient use of time
- They feel that some of the steps in the procedures can be combined or omitted or taken out of sequence and still achieve the required aim in a safe manner
- They feel that managers turn a blind eye to them cutting corners on procedures, however if something goes wrong then the responsibility lies with them.

From the manufacturer's point of view, it is important that the maintenance technicians understands precisely why the procedures are written as they are, and why they must be followed.

Evolution of Airbus maintenance documentation

The “ADAMS” research quoted above is dated January 1999.

Some of the reasons why procedures are not followed, because of the perception that there are quicker and easier ways to do, are certainly still in the mind of many people today.

However, technology has also progressed in the technical documentation domain in recent years. Mainly, with the successive introduction of digital data, and the development processes to establish maintenance documentation.

In this chapter, the concerns identified by the ADAMS research study published in January 1999, are highlighted below, and compared with how maintenance documentation technology today can respond to each of the concerns:

- *“Task card or the steps to complete the task were unclear*
- *Task needed guesswork or trial and error”*

- Response:
  - In today’s maintenance documentation, the introduction of colored illustration and text (see examples on the following pages)- is contributing to improved clarity and understanding, e.g. warning notes are written in red letters.

    Hyperlink navigation functions between text and illustrations are available for enhanced understanding, and significantly reduced elapsed time required to use the technical data.

    Most of the maintenance documentation is customized for the operator.

    The basic Airbus consultation tool (Airn@v) allows filtering function to read the data applicable to one aircraft.

    Airbus led the introduction of 3D animations in the maintenance manual for the more complex tasks, such as an engine change. The 3D animation function is today available for the A380, and is under study for other Airbus programs.

For example:

** ON A/C ALL

TASK 27-14-00-820-801-A
Adjustment of the Aileron

WARNING:MAKE SURE THAT THE SAFETY DEVICES AND THE WARNING NOTICES ARE IN POSITION BEFORE YOU START A TASK ON OR NEAR:

- **THE FLIGHT CONTROLS**
- **THE FLIGHT CONTROL SURFACES**
- **THE LANDING GEAR AND THE RELATED DOORS**
- **COMPONENTS THAT MOVE.**

MOVEMENT OF COMPONENTS CAN KILL OR INJURE PERSONS.

WARNING:MAKE SURE THAT THE TRAVEL RANGES OF THE FLIGHT CONTROLS ARE CLEAR.

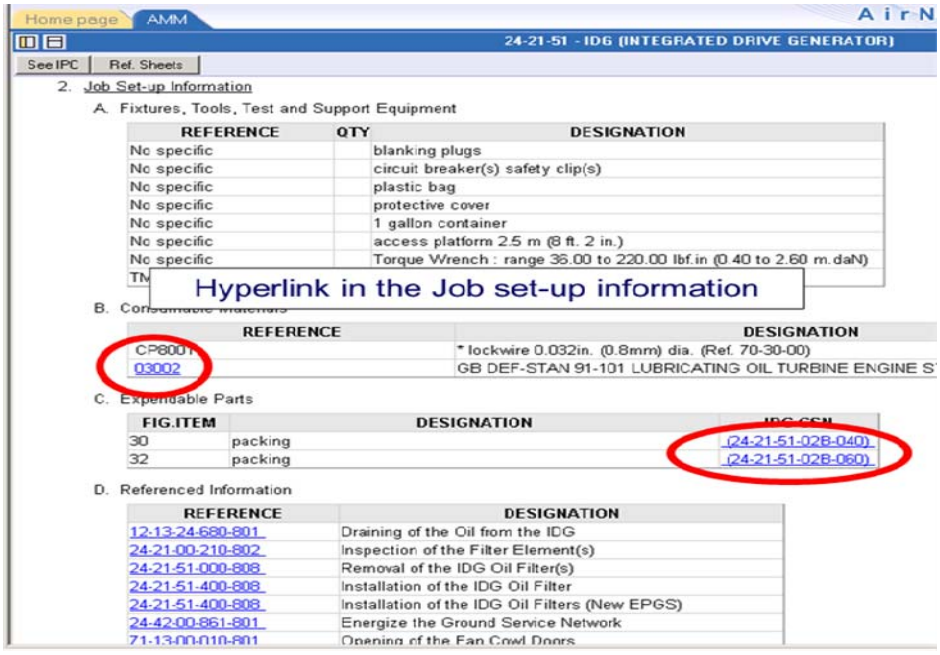
MOVEMENT OF FLIGHT CONTROLS CAN CAUSE INJURY TO PERSONS AND/OR DAMAGE.

1. Reason for the Job

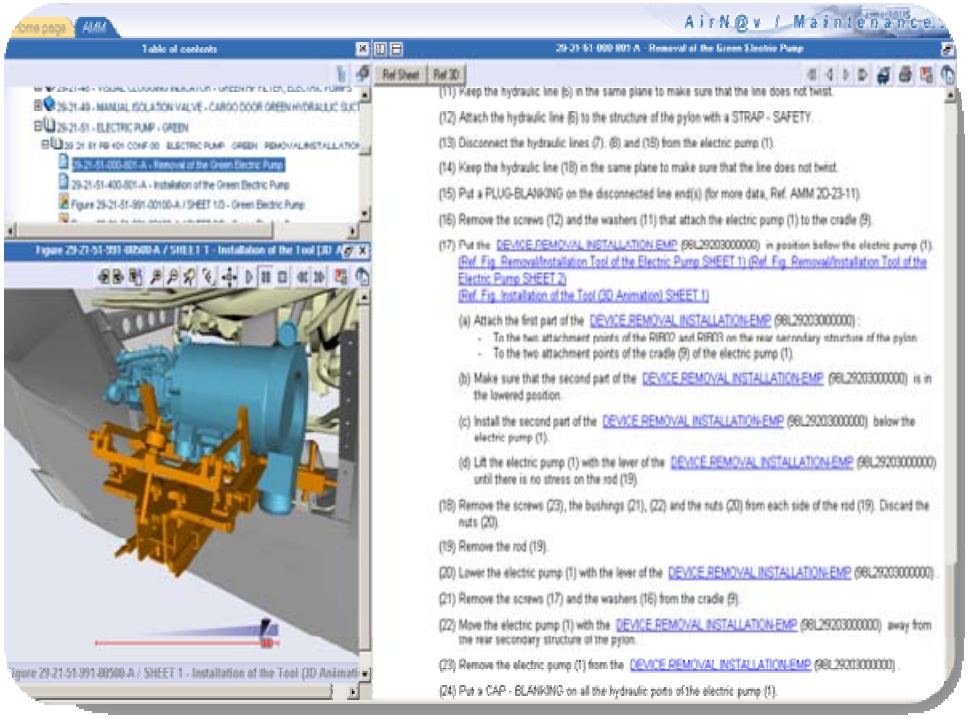
NOTE:This task can contribute to fuel savings.

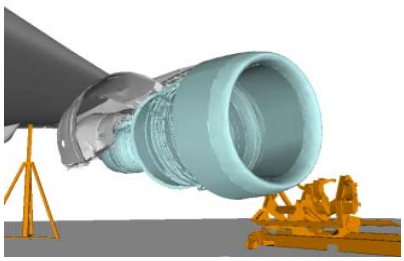
2. Job Set-up Information

Picture: Warning notes highlighted in red



Picture: Hyperlink function



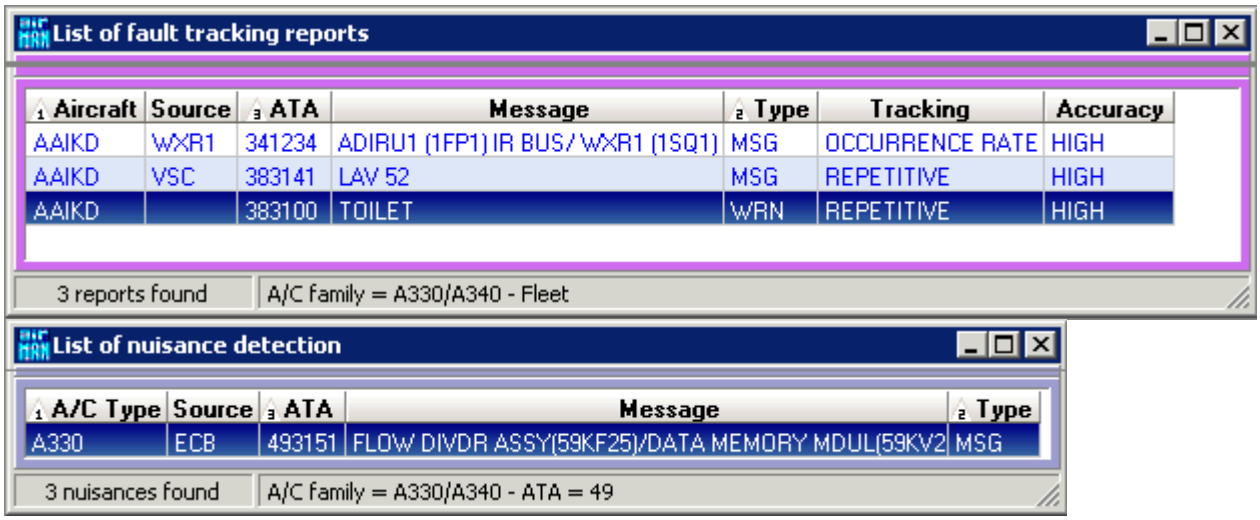


Picture: 3D Animations

- *"Aircraft maintenance history would have been useful but was unavailable*
- *They feel that not all of the procedures that they work to are necessary but have evolved over time as a reaction to specific incidents"*

- Response:
  - With AIRMAN, Airbus has developed a tool with the ability to follow in real time the status of any aircraft in the fleet, and be alerted immediately of faults and warnings occurring during flight.

    Memorization of experience, and maintenance history is part of the basic AIRMAN process if connected to a MIS. Successful maintenance actions are recorded and made available for future reference.



Picture: AIRMAN fault tracking function

Among other useful functions, AIRMAN can be connected to AirN@v, facilitating the consultation of the Airbus technical database.

- *"If they followed maintenance manual to the letter this would inevitably slow down their progress and make it difficult to meet deadlines as most procedures are either too simple or too detailed"*

- Response:
  - Maintenance procedures are no longer established and written in an "office environment", but validation and verification processes on an aircraft are in place for all new maintenance tasks.

    This includes that the maintenance tasks are tested together with airline maintenance personnel to ensure they meet the expectations of the end-users on the shop floor.

- *"Following procedures on routine tasks is not an efficient use of time*
- *They feel that some of the steps in the procedures can be combined or omitted or taken out of sequence and still achieve the required aim in a safe manner"*

- Response:
  - We have devoted the Maintenance Briefing Notes issued in August 2010 on the subject of routine tasks performance with the following conclusion:

    *"We are all engaged in **routine tasks** every day; and because they are so frequent, we risk being **complacent** when performing them.*
    *In most of the cases, such tasks are done without error. However, as human beings, we are not error-free all the time. Hence, perceived minor routine tasks can have **costly repercussions**.*
    *There is no ultimate solution to avoiding such occurrences. In this issue of the Maintenance Briefing Notes our aim was to simply **raise awareness** using in-service examples, highlighting the potential consequences for performing seemingly simple routine tasks.*
    *We encourage **reporting of such occurrences**, to assess the effectiveness of our documentation and procedures.*
    *Training and Quality departments may use such examples to **re-enforce** the message to their maintenance staff."*

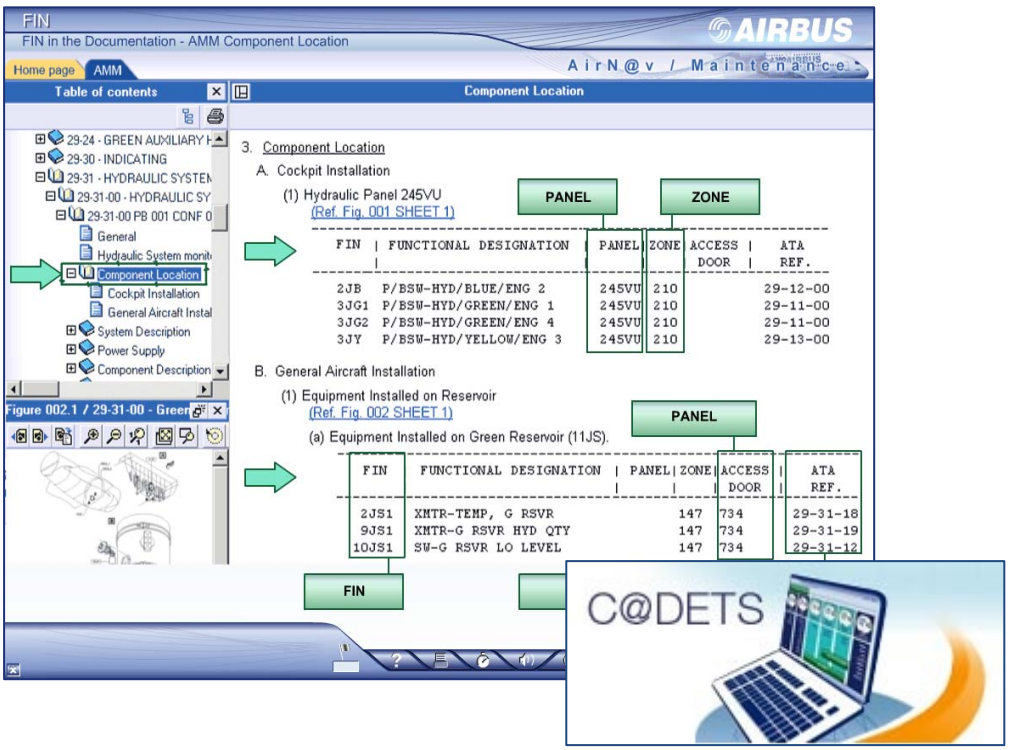
- *"They feel that managers turn a blind eye to them cutting corners on procedures, however if something goes wrong then the responsibility lies with them."*

- Response:
  - A subject that obviously needs to be addressed by internal company management culture.

    In support of training and quality departments, Airbus propose on-site familiarization courses for technical data and tools based on documentation related to maintenance, IPC, material, and repair documentation.

    In addition, the Airbus Technical Data package includes C@DETS (Computer @ssisted documentation Education Tutorial System).

    C@DETS is a self-tutorial courseware (available on CD-ROM and via AirbusWorld) which provides comprehensive training in the efficient use of Airbus technical data products and services, applicable to the full range of Airbus aircraft.



Conclusion

The evolution of technical data technology contributes to safety in maintenance operations, and improves the efficiency (usability) of maintenance documentation, thereby reducing maintenance costs.

The OEM can provide the tools, complemented by the following recommendations during daily maintenance:

- Discipline to adhere to authorized procedures, no short cut's.
- Review and adapt training to ensure consistency with updated, revised procedures.
- Attention to regulatory documents (e.g. AD's) which can identify tasks that apply to specific aircraft serial numbers, and be different to the OEM's standard manual.
- Don't use the alternative "…the better way of doing things…" until it is confirmed by the OEM.
- Record and report back events or difficulties where documentation is a contributing factor.
- Ensure access, facilities, and equipment for employees to use documentation.
- Ensure communication between the maintainer, technical data department and training

Summary

With this Maintenance Briefing Notes, we have highlighted the importance of maintenance documentation as a significant contributor to a safe and economically aircraft operation.

Research work has shown evidence that the failure to follow written procedures published by the OEM's, regulators or established locally, can lead to serious incidents.

The continues evolution of digital technology applied to maintenance documentation, and enhanced training, can help to respond to a number of concerns.

Complemented with best practices applied in daily maintenance operation, will help to improve safety and effiency.

We appreciate receiving feedback to this issue of the Maintenance Briefing Notes.

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Source reference:

1. Human-Centred Management Guide for Aircraft Maintenance: Aircraft Dispatch and Maintenance Safety (ADAMS). (2000)

   http://www.tcd.ie/Psychology/aprg/ADAMS.htm

2. United Kingdom Flight Safety Committee report on 2004 maintenance mishaps reported in Mandatory Occurrence Reports

Maintenance Briefing Notes

This Maintenance Briefing Note (MBN) is part of a set of Briefing Notes that provide an overview of the applicable standards, techniques, best practices, human factors, suggested company prevention strategies and personal lines-of-defense related to major threats and hazards that may affect maintenance.

This MBN is intended to enhance the reader's safety awareness but it shall not supersede the applicable regulations and the Airbus or airline's maintenance documentation; should any deviation appear between this MBN and the Airbus or airline's maintenance documentation, the latter shall prevail at all times.

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