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General Guide to Effective Aircraft Inspection

General Introduction

Inspection should be carried out in accordance with an agreed timeline – a single finding should not stop the process rather it should be noted & documented but the process to continue otherwise this can have significant repercussions of stopping and starting the program and finding more defects even at the end of the check.

Typically all inspection should be completed at the 20% completed point of the critical path timeline.

1/Building a Mental Model

How well do you know the area where you are performing your Inspection?

You should develop a mental model related to the structure or area being inspected. Particularly for complex structures, this is important to be able to recognize key features throughout the Inspection Process.

2/What is contained in your Mental Model?

Your Mental Model should include failure mode knowledge, so that you have an awareness of likely defects as well as to understand where maximum stresses occur.

Where possible the Mental Model should correspond with Inspection Documentation raising awareness of potential areas of concern.

The Inspector should then build on this acquired knowledge with specific inspection competence to enable an effective Inspection Strategy and to reduce the chance of missing defects.

3/ Shared Knowledge Improves Inspection Effectiveness

The greater the availability of information regarding potential and previous findings the greater the probability of detection, such information may be provided either by peers or by the system.

Inspectors develop their own expectancies of defect types, probabilities, severities and locations based on prior tasks and hangar "wisdom”

Important Note - If these expectations and sources are in error, defects can be missed. Use training and regular discussions of tasks to keep inspectors’ expectancies in line with the latest data.

4/ Use of Consistent Terminology

Terminology for describing defects as well as the associated standards can vary between Maintenance Organizations and even between inspectors in the same hangar.

The potential exists if inconsistent terminology is used for errors related to defect reporting to occur and can lead to ambiguities in Non-Routine Card (NRC) wording, and possible incorrect rectification action.

The documentation should give the inspector enough information to provide a consistent choice of inspection intensity. Terms such as “general”, “area” and “detailed” may mean different things to different inspectors, despite ATA definitions.

Caution

Documentation which is too general may lead to some frustration and reversion to previous to remembered versions. Ensure that Inspection error does not arise from using (erroneous) memory of previous work cards.

5/ Visual Inspection Tooling & Equipment

If correct equipment is not specified, inspectors may be tempted to find an alternate “workarounds” often this is informal and outside of Standard Operating Procedures (SOP’s) potentially contributing to sub-optimal working conditions and possibly increased errors.

A standard inspection kit that should be considered as personal to the Inspector consists of personal lighting, mirror, cleaning rag, ruler, and a loupe (A loupe is a small magnification device used to see small details more closely). Unlike a magnifying glass, a loupe does not have an attached handle, and its focusing lens is typically contained in an enclosing housing that protects the lenses when not in use.

Choose a loupe magnification that ensures detection. If necessary move the lens closer to the surface & decreasing the Field of Vision (FOV) if necessary increase the time spent on searching.

Note 1 - Poor equipment can make detection more difficult leading to missed identification of defects.

Regarding Support Equipment - It is important that support equipment can be moved into place easily and moved precisely as the task progresses.

Note 2 - If the inspector cannot manipulate these tools together (If mirror, flashlight and loupe are needed for a closer examination of a potential defect. But if they cannot all be used together, then the flashlight may be propped in a non-optimum position while the other tools are used.) – Potential for missed defect reporting.

Avoid any tendency to use unapproved tools for example - a sharp knife to check the elasticity of elastomer seals, or the use of a rag that catches on frayed control wires to inspect for fraying.

Human Performance Issues Related to Inspection

The time devoted to a focused search will improve the probability of detection and it is important that body alignment to ensure correct eye positioning to reduce the potential of muscular fatigue.

It is important for the inspector to allow enough time to complete an effective eye scan over the whole area.

However to note that extended time-on-task in repetitive inspection tasks causes loss of vigilance which leads to reduced responding by the inspector. (Indications are missed more frequently as time on task increases).

A good practical time limit is 20-30 minutes. Time away from search need not be long and can be spent on other non-visually intensive tasks.

Finding a defect will require additional time for detailed review and establishment of the defect (The remainder of the area must be searched just as diligently).

Inspection equipment - If it is not easy to use, inspectors may be tempted to use alternate equipment or not to move support equipment sufficiently or not often enough. (This can also lead to unsafe overreaching, hence to incomplete inspection coverage or injury to inspector.) Sub-optimal equipment leads to poor working postures and / or frequent body movements. Both can increase inspection errors.

Concerning units of measurement and documentation - If measuring equipment is not calibrated, or indifferent units from the documentation, then errors may be made and defects reported incorrectly will be made at the decision stage and defects not reported correctly.

Note – Documentation should always be fully compatible with the assigned task.

Should Inspectors mark the area? Some Inspectors like to mark the Inspection Area using temporary markers. Always ensure that marking does not encourage leaving items in the inspection area.

Caution Closure Errors - A common error in maintenance is failure to close after work is completed.

Ensure that procedures for close-up are adhered to, despite interruptions and time pressures, to prevent loss of closure errors.

Action to Take - Ensure mitigations are introduced to minimize the possibility of closure errors

Considering Interruptions - Loss of situation awareness for example during blade rotation can lead to missed inspection. Marking the search point reached when an interruption occurs will lead the inspector back to at least the current FOV.

Preparation & Cleaning

Perform a brief pre-inspection prior to cleaning as indications of leaks etc can be removed during cleaning and potential obscure defects.

However the importance of correct cleaning cannot be overstated as if the area is not cleaned sufficiently then, defects may be masked or hidden.

Note - Defects such as radius cracks can occur in structural positions that are somewhat difficult to clean and the probability of detection, therefore, decreases due to poor cleaning.

Concerning Glare & Contrast

Direct Inspection lighting which mainly comes from personal lighting (flashlight), which can potentially reduce the target background contrast, therefore lighting must be carefully considered to ensure we maintain the best contrast.

Glare reduces visual effectiveness dramatically and can lead to missed defects.

Area lighting can cause glare which reduces visual effectiveness dramatically and can lead to missed defects. (Glare can also occur with sunlight) especially where this light source is within the inspector’s visual field.

Contrast is a function of the inherent brightness and color difference between target and background. (The better the contrast the higher the probability of detection).

Hot Spots – Can occur when the lighting is not even across the Field of Vision and should be minimized where possible.

Note 1 - If a hot spot occurs, it can cause the eye to reduce pupil diameter, which in turn limits the eye's ability to see shadow detail with the potential for missed indications.

Note 2 - The ideal lighting for recognition and classification may not be the ideal for visual search. Search requires Strong contrast between indication and background.

Considering Criteria & Shared Experiences

Always encourage inspectors to share inspection findings and experiences Training provides an opportunity to understand to not only consider why events occur but to consider their consequences and to help the inspector consider the impact during different conditions.

Using Similar Structure as a "benchmark" to provide a comparison or reference standard to help judge free play, warping, discoloration, etc. Whilst this may be appropriate on occasion it is not always the case so take care and be open to discussing guidelines during training and recurrent retraining opportunities to avoid potentially "bad" decisions.

Building up a picture related to expectations is a positive – however over-reliance on this information can leave gaps related to unusual defects or unexpected conditions.

Whilst size may be judged visually wherever possible specific measurements should be added and recorded into the data as reference for the identified defects.

Looseness of fasteners may be checked by feel (haptic perception), particularly if the fastener is not readily accessible visually. Training & Support to develop approved procedures and training to ensure consistent inspection performance will prove beneficial in this regard.

Area by Area Search Strategy

A good search strategy ensures complete coverage, preventing missed areas of inspection.

Note - Inspection search performance decreases rapidly when the eyes are in motion, leading to a decreased probability of detection if the area is being searched for the first time.

Consider the benefit of searching for all defects in one area then moving on to the next as a technique which is both quicker and more effective.

Using an Aide Memoire can prove an easy source of reference material - A single page laminated sheet can provide a visual summary of defect types, readily available to inspectors whenever they take a break from the “hands-on” activity to re-acquaint with basic criteria.

Non-Visual Indicators

Touch, feel, and other sensory indicators can aid the inspection process. For example, a rivet may be found loose through touch, or a control run binding felt by roughness of movement.

Documenting Findings

Repairing defects correctly depends on clear indications of defect type, location and severity. Unfortunately, Inspectors have a tendency to be somewhat brief in their reporting, so always focus on subsequent checking and validation to ensure. Supporting a high level of clear communication will benefit the overall process.

Writing Defect Cards by hand may become an error-prone activity due to repetition where all common heading information must be entered repeatedly.

Ensure consistency regarding defect names and terminology, as errors of judgment, interpretation of severity and even repairs can arise.

Inspector Training

Training programs should support the inspector to gain competence and achieve a wide understanding of each defect type and methods to ensure recognition.

Consider support to provide guidance regarding non-visual standards during training will aid the overall inspection experience.

To promote the highest level of competence requires positive sharing of information analysis and decision making, consider the use of digital cameras and computer-based systems to promote remote decision-making support and guidance.

Aircraft Inspectors, benefit from performance feedback if they are to make decisions effectively. Such mentoring systems can provide a positive level of engagement as well as a positive safety culture.

Further Guidance

Sofema Aviation Services (SAS) www.sassofia.com and SofemaOnline (SOL) www.sofemaonline.com provide training for aircraft inspectors delivered as classroom, webinar & online.

For further details please email team@sassofia.com