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HUMAN FACTOR INFLUENCE ON EDDY CURRENT NON-DESTRUCTIVE TESTINGS

Carlos Eduardo Sanches da Silva¹(*), Rita Cristina Renó Ferreira², Yasmin Silva Martins¹, Dalton Garcia Borges de Souza¹, Ana Carolina Oliveria Santos¹

¹Graduate Program in Industrial Engineering, Universidade Federal de Itajubá (UNIFEI), Brasil

²Empresa Brasileira de Aeronáutica (EMBRAER), Brasil

(*)*Email*: cadusanches02@gmail.com

ABSTRACT

The damage detection in structural components is of extreme importance, because damages that begin in microscopic scale can propagate, causing a structure exposure. The non-destructive tests are used to detect in time this kind of damage. One of the most used methods is one that detects damages through eddy current.

This work evaluates the human factor influence in this kind of testing in aeronautical structures maintenance, because the result of an eddy current inspection has high dependence of inspector's conditions. This research used Design of Experiments and followed the steps: problem characterization, influence factors and levels, selection of answer variables, determination of a design of experiments model, experiment run, data analysis and finally conclusions and recommendations.

The objective of this research was to identify and evaluate the factors present in human action of inspection by eddy current method, and to contribute to the reliability of the structural damages detection. The influence factors and levels chosen are as follows: (i)-inspection difficulty (classified as easy or difficult), (ii)-presence of conditions that causes stress in the inspector (classified as yes or no) and (iii)-inspector's experience (classified as young or expert). The response variables are: (a)-inspection time and (b)-result (the variable result indicates if there was or not a correct diagnosis related to presence of damages in the structural item). The analysis of data allowed to conclude that, to the studied case, the most influent factor in both inspection time and result has been the inspector's experience. This confirms the Norm NAS 410, which is based upon the time of inspector's experience as a preponderant factor to the reliability of the eddy current non-destructive testing.

Keywords: human factor, non-destructive testing (NDT), design of experiments.

INTRODUCTION

The aeronautical industry has its own characteristics. Flights, crews and maintenance have to be scheduled. Fuel, spare parts, tools, training and publications have to be provided. With all these factors, it is necessary to consider the costs of operation and maintenance, which are time and money (Knotts, 1999).

In the view of Salamanca and Quiroz (2005), the costs of maintaining aeronautical structures, taking into account non-destructive inspections, repairs and replacements of damaged components, have a high priority in the management of the fleet.

Research has been carried out in the evaluation of the influence of the human factor in non-destructive tests, such as: Moré *et al.* (2003); Stefhens (2000); Wassink and Dijkstra (2007).

Crocker (1999) cites that it is often assumed that inspectors are infallible, that they will always see a crack if they are present and that they would never reject a component unless it was in an unsatisfactory condition. If inspections were always one hundred percent effective, then the inspector would always find a crack, corrosion or external damage if present, and would never reject a component unless a fault was present. Although the consequences may be different, false positives (reporting a crack when it does not exist) and false negatives (failing to detect a crack that is present) are both bad for the operational effectiveness of a system. A false positive can lead to removal of the item, leaving the system unnecessarily unnecessary, and exposing it to the possibility of damage induced during maintenance. A false negative can put human lives at risk and also result in the loss of the aircraft.

The research described presupposes the growing complexity of systems and seeks to study human behavior, which results in decisions about product conformity. With emphasis on inspections, common in the food, mechanical and aeronautical industries, where the inspector has a preponderant role in approving or failing the inspected product, the human factor becomes fundamental to the reliability of the inspection processes. Thus, the training of an inspector begins with the job description and is complemented by on-the-job training based on standardizations such as NAS 410 which establishes minimum standards for qualification and certification of personnel involved in nondestructive testing.

In this context, given the importance of the theme, the present work aims to evaluate the influence of the human factor in non-destructive tests by parasitic currents in the maintenance of aeronautical structures.

RESULTS AND CONCLUSIONS

Table 1 summarizes the observations after data analysis.

Table 1 - Evaluation of the factors present in human inspection by non-destructive testing.

Selected Factors	DOE Results	General comments
Person	<p>Regarding the inspection time, it was the most statistically significant factor.</p> <p>With regard to the correct answers and errors, 100% of the inspectors considered experienced correct the result.</p>	<p>The researcher observed that actually the experience time was what most influenced the time of the inspection and the correctness and errors. Experienced inspectors demonstrated great safety during inspections.</p>
Difficulty	<p>With regard to the inspection time, the difficulty of the inspection had an influence not as great as the experience and not as small as the stress.</p> <p>Regarding the correctness and errors, considering the inspections performed on structural items considered difficult to inspect, there was a 62.5% hit and an error in 37.5% of the inspections. And considering the inspections performed on items considered easy to inspect, there was a 75% hit and an error in 25% of the inspections.</p>	<p>The researcher noted that the inspection of difficult parts did not cause reactions of insecurity, especially with respect to the inspectors considered experienced. The existence of a system-based procedure based on NAS 410 provides a peace of mind to inspectors with less experience, as they know that their inspection will be checked by a more experienced inspector.</p>

<p>Stress</p>	<p>Regarding the time of inspection, it was the variable that had the least influence.</p> <p>Regarding the correctness and errors, considering the inspections that were not performed under conditions that caused stress, there was a 62.5% hit and an error in 37.5% of the inspections. Considering the inspections carried out when the conditions causing stress were present, 75% of the inspections and 25% of the inspections were correct.</p>	<p>Although not considered statistically significant, the researcher observed that the inspectors appeared to be much calmer during inspections performed in the morning and in an environment without parallel conversation. Under stressful conditions, it was observed that young inspectors were more focused on carrying out the inspection.</p>
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In the case studied, through a more quantitative approach, it was verified that the time of experience of the inspector, which is related to the nature of the individual, was a factor that had great influence. These findings confirm NAS 410, which addresses the requirements for the qualification and certification of personnel involved in the application of nondestructive testing. The standard says that there should be a minimum training load for the inspector to obtain his certification.

The DOE statistical tool proved to be efficient and allowed to conclude that the results obtained in the case studied are consistent with the NAS 410 standard. This standard gives more security to the process and to the inspectors, since it guarantees that the results of the inspections done by inspectors with little experience will pass by the approval of more experienced inspectors.

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