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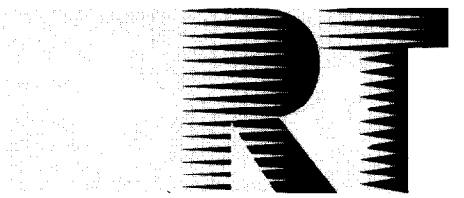

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(Degré de fiabilité des visites d'inspection des cellules en dépôt et en conditions opérationnelles)

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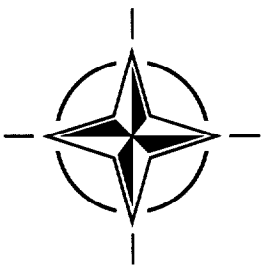

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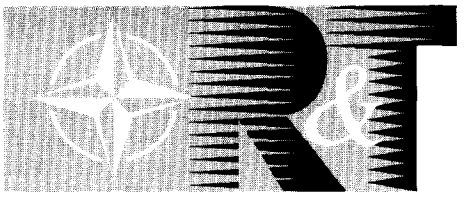

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Airframe Inspection Reliability under Field/Depot Conditions

(RTO MP-10)

Executive Summary

Non-Destructive Inspection (NDI) reliability is the corner stone of the safety-by-inspection approach for continuing airworthiness of aging aircraft and of the damage tolerance philosophy adopted by many of the NATO members as the basis for ensuring continued airworthiness. Inspection reliability data, usually in the form of technique threshold data and Probability of Detection (POD) data are essential for evaluating the applicability of selected inspection techniques. These data also are used to derive inspection thresholds and inspection intervals. Frequency and method of inspection are primary drivers of maintenance costs and therefore there is pressure to delay onset and reduce frequency. Safety depends on inspection reliability; therefore there is pressure to be conservative in defining onset and frequency. These competing aspects can only be properly evaluated with representative inspection reliability data.

The Workshop had the general objective of promoting general discussion on the merits of the whole concept and use of NDI reliability data in the life cycle management process, including both deterministic and probabilistic approaches. The specific aim of the Workshop was to explore the concept of deriving airframe inspection reliability using field inspection results.

Three overview papers were presented from the perspectives of an end user of inspection reliability data, a researcher in the analysis of data to derive reliability information, and an industrial expert in the definition and application of NDI techniques. It was apparent that NDI reliability is a major influence in the definition of techniques to be applied and their frequency. The parameter used to characterize inspection reliability is Probability of Detection (POD) and the generally accepted target reliability is 90 percent POD at a 95% confidence level.

The derivation of POD statistics was explored. Primarily, this is done with "round-robin" evaluation programs. Human factors were identified as a major element that can affect reliability but are not addressed in these evaluation programs. Analytical methodologies used to derive POD statistics from relatively small data sets were presented and it is apparent that the methods are not standard, and this two organizations using the same data could derive different POD values.

Other papers discussed potential ways that field inspection results could be used to derive POD information. Benefits from this approach include the fact that there is a consideration of human factors built into this approach as well as possible cost reductions by avoiding costly round robin programs. Data deficiencies, both in quality and quantity, were cited as an obstacle to progress. Advanced techniques ranging from enhanced optical inspections and radiography through to unique applications of existing eddy current processes were presented from a reliability viewpoint. Automation is a major advance in improving inspection reliability because it reduces human factor influence.

In conclusion, while there was a consensus that inspection reliability information is a fundamental requirement for effective life cycle management, there was no consensus on who "owned" the requirement to develop and validate the data. Is it the regulators, the operators, the NDI development community or the research community? A recommendation arising from the round table discussion was to form a Working Group to define methods to implement NDI reliability assessments from service data.

Degré de fiabilité des visites d'inspection des cellules en dépôt et en conditions opérationnelles

(RTO-MP-10)

Synthèse

La fiabilité des visites d'inspection par des méthodes non-destructives (NDI) est l'une des pierres angulaires des inspections de sécurité pour maintenir l'aptitude au vol des flottes aériennes d'ancienne génération. Elle est aussi l'une des composantes du principe de la tolérance aux dommages subis adopté par bon nombre des pays membres de l'OTAN comme le garant du maintien de la navigabilité.

Les données sur la fiabilité des visites d'inspection, généralement présentées sous forme de renseignements sur les seuils d'identification des caractéristiques techniques et la probabilité de détection (POD), sont indispensables pour l'évaluation de l'applicabilité des techniques d'inspection choisies. Ces données servent également à la détermination des niveaux et des intervalles des visites d'inspection. Les coûts de maintenance dépendent principalement de la périodicité et de la méthode d'inspection adoptées. Par conséquent, il est financièrement intéressant de repousser le début des visites d'inspection et donc une approche conservatrice s'impose en ce qui concerne la définition de la date de début des visites et leur périodicité. L'évaluation de ces aspects divergents ne peut s'obtenir qu'avec des données représentatives de la fiabilité des visites d'inspection.

Cet atelier a eu pour objectif de créer un forum pour faciliter une discussion d'ensemble sur les mérites du concept et l'applicabilité des données de fiabilité NDI pour la gestion du cycle de vie, en tenant compte des approches tant déterministes que probabilistes. L'atelier a eu pour thème particulier l'examen de l'état actuel des connaissances technologiques en ce qui concerne l'obtention de la fiabilité dans le domaine de l'inspection des cellules en conditions opérationnelles.

Trois communications donnant un aperçu général de la question ont été présentées. Elles représentaient trois points de vue différents: celui d'un utilisateur des données sur la fiabilité des visites d'inspection, celui d'un chercheur dans le domaine de l'analyse des données intéressé par l'extraction de données sur la fiabilité et celui d'un représentant de l'industrie, spécialisé dans la définition et l'application des techniques NDI. Il est apparu très clairement que la fiabilité des techniques NDI est un facteur important pour définir les techniques à appliquer ainsi que leur périodicité. Le paramètre utilisé pour caractériser la fiabilité des visites d'inspection est la probabilité de détection (POD) et le degré de fiabilité généralement admis est de 90% du POD pour un coefficient de confiance de 95%. Cet objectif de fiabilité a été discuté dans le détail. De l'avis général, quoique ces valeurs soient normalement appropriées, elles ne peuvent pas être considérées comme définitives.

Plusieurs communications ont concerné l'origine des statistiques sur le POD. Ces statistiques sont généralement obtenues par le biais de programmes d'évaluation "en rond". Les facteurs humains ont été identifiés comme un élément important, pouvant affecter la fiabilité, mais ces programmes d'évaluation n'en tiennent pas compte. Des méthodologies analytiques utilisées pour l'extraction de statistiques POD d'ensembles de données relativement restreints ont été présentées. Il a été constaté que les méthodes ne sont pas uniformisées et que, par conséquent deux organisations travaillant sur les mêmes données pourraient obtenir des résultats différents.

D'autres communications ont examiné les résultats de visites d'inspection réalisées en conditions opérationnelles comme sources de données POD. L'un des avantages de cette approche est qu'elle tient compte des facteurs humains. En plus, elle permet de réduire les coûts en évitant les programmes d'évaluation "en rond" coûteux. Des carences dans les données, tant quantitatives que qualitatives, ont été citées comme un obstacle au progrès.

Des techniques avancées allant des inspections optiques améliorées et de la radiographie jusqu'à certaines applications uniques de méthodes d'inspection par courants de Foucault ont été présentées du point de vue de la fiabilité. L'automatisation représente un pas important vers l'amélioration de la fiabilité des visites d'inspection, car elle réduit l'influence du facteur humain.

En conclusion, bien qu'un consensus se soit dégagé sur le fait que la fiabilité des visites d'inspection est essentielle à la gestion effective du cycle de vie, aucun consensus n'a été trouvé en ce qui concerne la "responsabilité" du développement et de la validation des données. Est-ce que cette tâche incombe aux régulateurs, aux opérateurs, à la communauté de développement du NDI ou bien aux chercheurs? Lors de la table ronde il a été proposé de former un groupe de travail afin de définir des méthodes permettant de mettre en œuvre les évaluations de la fiabilité des techniques NDI obtenues à partir de données opérationnelles.

Contents

SESSION III: ANALYTICAL ISSUES RELATED TO GENERATION AND USE OF PROBABILITY OF DETECTION DATA

SESSION IV: PRACTICAL EXPERIENCE AND CASE STUDIES

Preface

Inspection reliability is one of the corner stones of the safety-by-inspection approach for continuing airworthiness of aging aircraft and of the damage tolerance philosophy adopted by many of the NATO members as the basis for ensuring continued airworthiness. Inspection reliability data, usually in the form of technique threshold data and Probability of Detection (POD) data are essential for evaluating the applicability of selected inspection techniques. These data also are used to derive inspection thresholds and inspection intervals. Frequency and method of inspection are primary drivers of maintenance costs and therefore there is pressure to delay onset and reduce frequency. Safety depends on inspection reliability; therefore there is pressure to be conservative in defining onset and frequency. These competing aspects can only be properly evaluated with representative inspection reliability data.

Most available NDI reliability data results from dedicated round-robin inspection programs, whereby the same samples are inspected by disparate technicians under laboratory type conditions. These data have been frequently challenged on the basis of non-representativeness of the inspection conditions in terms of environment, access and human factors. Analysis of in-service NDI findings can improve our understanding of the reliability of NDI. This greater confidence in NDI reliability would allow more effective use of NDI for maintaining airworthiness. As an added benefit, by using field data, costs of generating POD statistics could also be reduced.

Significant numbers of in-service detections are occurring, but at present there is no organized process whereby these data are collected and collated for NDI reliability studies. One of the prime purposes of this Workshop and of these proceedings is to raise the profile of using field/depot data for POD determination and to open discussion on the processes under which this data could be collected and analyzed. This intent has been met.

The Workshop was well attended with over 50 attendees. The meeting concluded with a well attended Round Table Discussion. A summary of the main issues and recommendations arising from the presentations and discussions is provided in the Recorder's Report by Professor Doctor J. Schijve.

D.L. Simpson
Chairman
Sub-Committee on
Airframe Inspection Reliability

SUB-COMMITTEE MEMBERS

Chairman

Mr D. SIMPSON
Chief, Structures
Structures & Materials Laboratory
Institute for Aerospace Research
NRC
Montreal Road
OTTAWA, Ontario K1A 0R6

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Fatigue (materials)	Inspection
Service life	Reliability
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Failure analysis	Quality assurance

14. Abstract

Contains the papers presented at a Workshop on Airframe Inspection Reliability under Field/Depot Conditions organised by the Applied Vehicle Technology Panel (AVT) of RTO, in Brussels, Belgium, 13-14 May 1998.

The Workshop had the general objective of promoting general discussion on the merits and practicality of generating NDI Probability of Detection (POD) from in-service data and on the use of reliability data in the life-cycle management process.

The papers are presented under the following headings:

- Perspectives on: (i) the role of NDI, (ii) factors influencing eddy current POD in the field environment, and (iii) NDT reliability
- Estimation from small samples and in-service experience
- Approaches to POD generation
- Analytical issues related to generation and use of POD data
- Practical experience and case studies

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