

# ADF Introduction of Thermography Capability

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## PRESENTATION SCOPE

- Thermography Inspection Types:
  - Passive Thermographic camera looks at the heat source ie hot electrical connection, hot air leak, hot bearing, water in honeycomb panel, etc.
  - Active Thermographic camera looks at heat diffusion following application of energy from a external source.
  - This presentation will be on the introduction of flash thermography (Active).





## INTRODUCTION

- Scope:
  - Who is DAVENG-DASA (NDT&CT).
  - What is Flash Thermography.
  - Why Introduce Flash Thermography.
  - The Flash Thermography Introduction Process.
  - <u>Current Introduction Progress.</u>





## DEFENCE AVIATION SAFETY AUTHORITY

Non Destructive Testing and Composite Technology (NDT&CT) are a sub branch of the Directorate of Aviation Engineering (DAVENG). NDT&CT primary role:

- Training. NDT&CT delivers specialist training in Non Destructive Testing (NDT) and Aviation Composite Technologies (ACT) to ADF and Industry, including re-certification's.
- Engineering Support. NDT&CT design 21J NDT procedures to support the continuing airworthiness and structural integrity of ADF platforms.
- **Subject Matter Experts** to the ADF on NDT & ACT.
- **Authority.** Prescribing AMC & GM for DASR.





## DASA - DAVENG (NDT&CT) CAPABILTY

- Non Destructive Testing:
  - NDT Training to EN 4179,
  - 21 J NDT Procedure development,
  - Introduction of enhanced or new technology,
  - Sponsor for ADF Non Destructive Testing publication, and
  - SME advice.
- Aviation Composite Technologies
  - Composite repair training,
  - Introduction of new composite repair practices, and
  - SME advice.





#### WHAT IS FLASH THERMOGRAPHY







## WHY INTRODUCE FLASH THERMOGRAPHY

- DAVENG-DASA has mandate to introduce new technologies.
- Thermography is well suited for the inspection of carbon fibre composite panels.







## WHY INTRODUCE FLASH THERMOGRAPHY

- DST-Group had been researching developments in the thermography for a number of years and produced a report on successful MRH 90 aircraft field trials.
- The Royal New Zealand Airforce has identified flash thermography as a means to conduct localised inspections on their NH90 (AUS MRH90).







#### FLASH THERMOGRAPHY INTRODUCTION PROCESS

- Understanding flash thermography.
- Equipment selection.
- Conducting trials and developing a general procedure to allow use of flash thermography on ADF aircraft.
- Developing a NDT level 2 course to train ADF technicians on the use of flash thermography.
- Identifying wider application of flash thermography within the ADF.





#### INTRODUCTION PROCESS: UNDERSTANDING FLASH THERMOGRAPHY

- Source thermography courses provided by domestic and international providers.
- Approach DST-Group for mentoring and SME advice.
- Design and manufactured composite test pieces to conduct trials.





#### INTRODUCTION PROCESS: EQUIPMENT SELECTION (THERMOSCOPE 3)





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## DISPLAYED ALGORITHMS – IMPACT DAMAGE



Log - Log

#### 1<sup>st</sup> Derivative

#### 2<sup>nd</sup> Derivative

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#### INTRODUCTION PROCESS: PROCEDURE DEVELOPMENT

- NDT&CT procedures state a size of discontinuity that the procedure should reliably detect.
- Procedure development trials are conducted to assess the capabilities of the technique.
- Independent verification and validation trials are conducted to provide a level of confidence in the sensitivity of the procedure.
- Target delamination size to find: 10mm Ø at ~2.0mm deep.





## **TEST PANEL CONSIDERATIONS**

- Effects of copper mesh.
- Simulating delaminations.
- Effects of different aircraft coatings.
- Effects of build differences ie autoclaved vs vacuum bagged repair.
- Effects of testing curved surfaces.





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## MANUFACTURE OF ARTIFICIAL DELAMINATION

- Criteria include:
  - Similar thermal characteristics to actual delamination.
  - Thermal response to be repeatable.
  - Ease of manufacture.
  - Repeatability of manufacture.
  - Low cost.
  - Ability to control the depth of delamination.
  - Ability to control the size of delamination.





#### SIMULATED DELAMINATION

- Flat Bottom Holes.
- Metallic strips.
- Mechanically induced laminate separation.
- Teflon Insert
  - Commonly used to simulate thermal defects.
  - Can be thermally similar to resin in the panel.



#### **MECHANICALLY INDUCED** LAMINATE SEPARATION





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#### FLAT BOTTOM HOLE WITH CFRP INSERT



CROSS SECTION OF INSERT IN CFRP FLAT BOTTOM HOLE ©

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## TEST PANEL TO COMPARE DELAMINATION TYPES

- Test Panel 1
  - 21 Ply Carbon Fibre Reinforced Plastic (nominal thickness of 5.1mm).
- 4 x 10mm Ø Flat Bottom Holes (FBH) to give delaminations at approximately 2.5mm depth as follows:
  - 1 FBH open.
  - 1 FBH with Teflon and CFRP plug inserted.
  - 1 FBH with CFRP plug inserted with 0.2mm air gap.
  - 1 FBH and CFRP Plug inserted fully (simulated kissing bond).





# RESULTS OF TEFLON VS FBH TRIALS

- 4 FBHs visually determined the following order of greatest contrast:
  - FBH open.
  - FBH with CFRP plug inserted with 0.2mm air gap.
  - FBH with Teflon and CFRP plug inserted.
  - FBH and CFRP Plug inserted fully (kissing bond).



## LINE PROFILE FOR TEFLON VS FLAT BOTTOM HOLE





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## EFFECTS OF VARIATIONS IN AIRCRAFT PAINT

- Variations in paint colour and finish will effect the absorption of the flash lamp energy.
  - Shiny white paint poor energy absorption.
  - Matt black paint good energy absorption.
- Damage to paint will show up in the thermal image and locally effect energy absorption.





## **CORRECTING AIRCRAFT PAINT VARIATION**

- The application of a matte black paint prior to testing
  - Normalises emissivity (absorption of radiated energy).
  - Provides a uniform surface finish for all test items.
  - Ensures consistent test results.
- Dupli Colour Matte Black Custom Wrap paint identified as suitable.



#### COMPARISON OF EMISSIVITY OF BLACK PAINTS



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#### HIGH EMISSIVITY REMOVABLE COATING (HERC)



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## DIFFERENCES IN PANEL BUILD

- Initial trials were conducted on test panels manufactured using the vacuum bag method.
- Trials on scrap aircraft panels revealed less thermal penetration than the test panels.
- Vacuum bagged panels Lower fibre to resin ratio than those cured using an autoclave.
- Heat dissipates faster in carbon than epoxy resin.



#### MANUFACTURING TECHNIQUES





#### Vacuum Bagged

#### Autoclave







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#### EFFECT OF PANEL CURVATURE



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## **CURRENT INTRODUCTION PROGRESS**

- Flash Thermography General procedure developed for inspecting aircraft carbon fibre composite materials.
- 'Round Robin' trials with ADF and RNZAF in progress to ensure general procedure sensitivity is appropriate.
- Flash thermography NDT Level 2 course currently being developed (focusing on aircraft composite testing).



# QUESTIONS

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