



UK MOD  
DEFENCE SCIENCE & TECHNOLOGY  
LABORATORY (DSTL)  
EWIS RESEARCH PROGRAMME

Aircraft Airworthiness & Sustainment Conference

Brisbane, Australia

6<sup>th</sup> July 2018

# CCS INTRODUCTION

- UK MOD's current Subject Matter Experts for all things EWIS.
- Have held this position for the past 12 years.
- CCS carry out the following work on behalf of the UK MOD:
  - Active committee members for the following EWIS standards bodies:
    - European Standards
    - British Standards
    - Defence Standards
    - SAE
  - Members of the following work groups:
    - US Science & Technology Group
    - US Joint Service Action Wiring Group (JSWAG)

# CCS INTRODUCTION

- Advice and Assistance Helpdesk available to all platforms within the MOD air environment.
- Inventory data cleansing and rationalisation.
- Advise on training content:
  - Precision Term ination Tooling
  - Wiring Husbandry
- Laboratory Support.
- Manage and update numerous Defence Standards.
- Advise wiring integrity platform working groups.
- Advise and draft MOD EWIS Policy.
- Manage and update numerous EWIS Air Publications.

# UNDERSTANDING AGEING AIRCRAFT

**dstl** **Inter-war**

**1910s**

**1920s**

**1930s**

**1940s**

**WWII**

**1950s**

**1960s**

**1970s**

**1980s-90s**

**1990s**

**2000s-10s**

**Future**

**Defence science and technology supporting the Royal Air Force**

**Modern**

**2009**

**Understanding ageing aircraft**

The aim of the Understanding Ageing Aircraft programme was to identify, develop and pull through skills, knowledge and capabilities to support airworthiness, reduce the cost of ownership and improve availability of the ageing aircraft fleets. Ageing is defined as the degradation of the system over time, leading to an increased cost.

The programme has delivered key capability enhancements by: addressing electrical wiring and interconnection systems; enhancing corrosion protection and prevention measures; developing cost-effective fixed-wing and rotary-wing usage monitoring systems.

This programme has reaped significant benefits to the RAF in terms of safety / airworthiness, cost of ownership and aircraft availability.

# UNDERSTANDING AGEING AIRCRAFT

- The UK MOD Defence Science and Technology Laboratory (dstl) undertook a review of the threats to ageing military aircraft and identified key areas where research and development could potentially provide a valuable contribution to the continuing airworthiness of ageing aircraft fleets.
- Key areas identified were:
  - Forensic Capability Development
  - Corrosion Protection
  - Low Cost Structural Usage Monitoring
  - Information Systems Development
  - Electrical Wiring Systems

# PARTNER ORGANISATIONS

- Industrial Support Base
  - AACE
  - Aviation Support Consultants
  - BAE Systems
  - Bristol University
  - CableConnect Solutions
  - Dennis Taylor Associates
  - Helisac
  - Musketeer Solutions
  - Qinetiq
  - RAE Structures
- UK MOD
  - Military Aviation Authority (MAA)
  - Defence Equipment & Support (DE&S)
  - 1710 Naval Air Squadron
  - RAF Waddington
  - RAF Benson

# STAGE 1

## EWIS RESEARCH PROGRAMME

- The initial programme considered the following EWIS elements:
- CADMIUM CONNECTORS
  - Cadmium Corrosion Review – based on a ‘Duty of Care’ for personnel
- CIRCUIT BREAKERS
  - Thermal Circuit Breaker Testing – looking at potential operation issues

# CADMIUM CONNECTORS

Corrosion Category	Description, observations	Handling advice
<b>Severe</b>	Extensive corrosion seen, some flaking, very powdery corrosion product, substantial pitting, with a proportion able to detach, surface disrupted, possible localised depletion of cadmium, substrate exposed or corroded.	Toxic particulate threat possible. Approach with caution; seek advice where not conversant with cadmium corrosion products. Use of latex gloves, Full face mask and disposable overalls is mandatory.  Risk assessment required.
<b>Bad</b>	Powdery white surface, significant patches of mottling (pronounced pitting), some loose corrosion product and flaking possible. Substantially worse corrosion will be seen in obscured areas.	Toxic particulate threat possible. Approach with caution; seek advice where not conversant with cadmium corrosion products. Use of latex gloves, Full face mask and disposable overalls is mandatory.  Risk assessment required.
<b>Moderate</b>	Light powdery surface populated with some spots or grainy white pimples (some pitting), base of threads or partially concealed areas exhibiting higher degrees of damage. Appearance like a salt has been dried on to the surface.	Moderate caution, corrosion product dormant if left undisturbed. Latex gloves should be used where contact is unavoidable. Dusk mask, goggles and disposable overalls required if dust is evident.
<b>Light</b>	Mild pale partial tarnish (faded green appearance for olive drab electrical connectors), some minimal white spotting to the surface (referred to as 'White blooms').	Minimal threat, latex gloves where possible.
<b>Negligible</b>	No corrosion products evident. Surface retains original shiny lustre.	Minimal threat, latex gloves where possible.



# CIRCUIT BREAKERS

- Following the US NAVAIR Circuit Breaker Test Programme, the UK MOD carried out a similar test programme with a reduced sample size in order to confirm the US findings.
- UK Programme took 35 circuit breakers from in-service aircraft and tested to product specification:
  - **42%** failed some part of the specification requirement.
- 20 unused circuit breakers also tested to product specification:
  - **35%** failed some part of the specification requirement.
- These results replicated the US findings and confirmed the need for circuit breaker maintenance.

## RESULTING CHANGES

- The UK MOD introduced a periodic cycling requirement for all thermal circuit breakers installed on aircraft and the cycling of CB's prior to installation.

# STAGE 2

# CRADLE TO GRAVE PROGRAMME

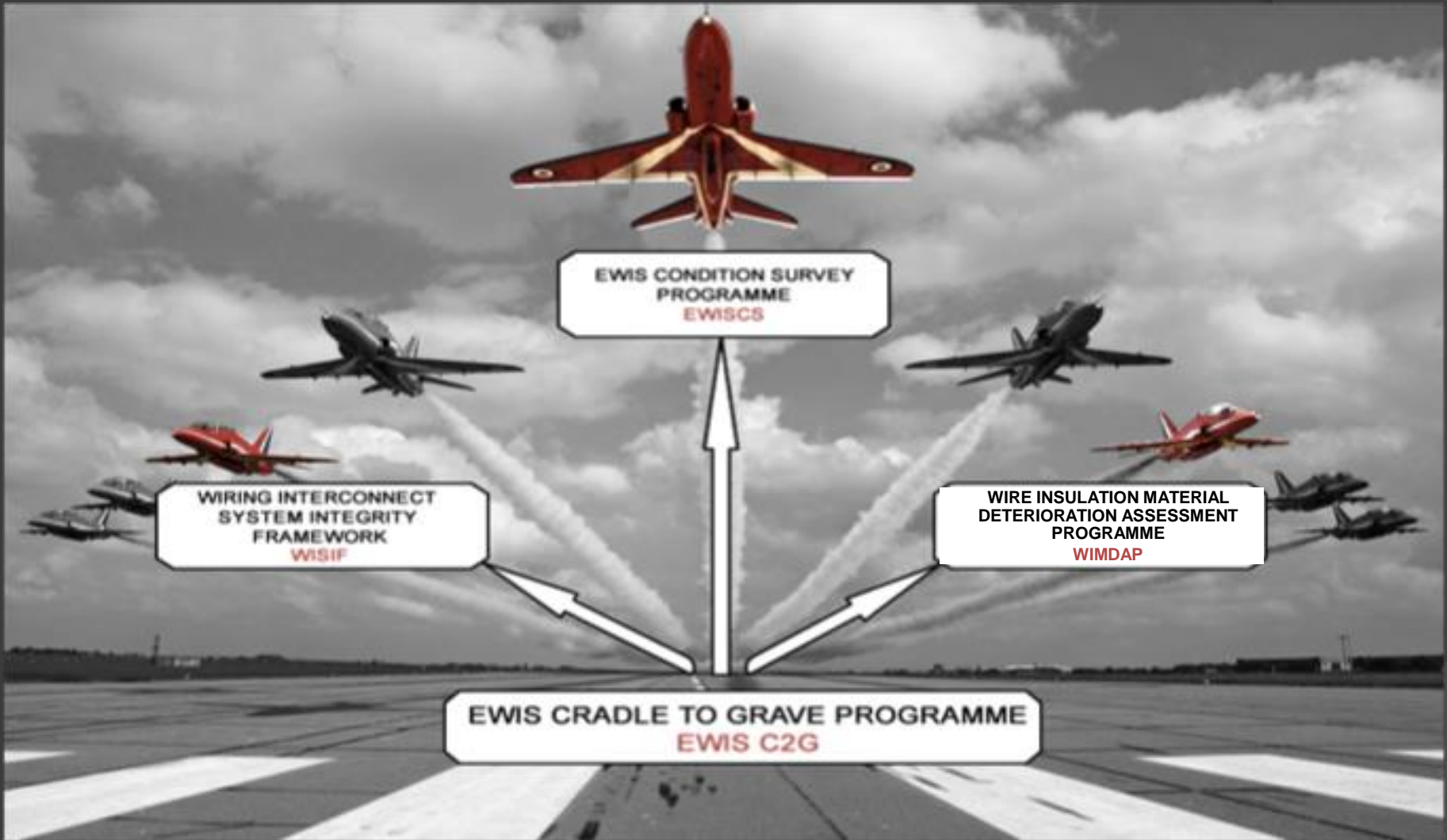
## THE PROGRAMME

- The Defence Science & Technology Laboratory (dstl) set up an EWIS Cradle to Grave (C2G) programme, managed, coordinated and carried out by CableConnect Solutions (CCS) Ltd.

## THE AIM

- Inform policy required for future EWIS installations and provide tools for determining EWIS in-Service condition.

# CRADLE TO GRAVE PROGRAMME



# WISIF

## WIRING INTERCONNECT SYSTEM INTEGRITY FRAMEWORK

### AIM

- To produce a guidance document detailing best practices for the management of MOD aircraft EWIS from 'cradle to grave'.

### RATIONALE

- The MOD currently lacks guidance on the management of EWIS throughout the life of an aircraft.
- Poorly managed EWIS can lead to airworthiness issues.
- Virtually all aircraft rely heavily on the health and integrity of EWIS for safe operation.

# CONSIDERATIONS

- The following research was undertaken to establish the best information to be included in the document:
  - Review of the current practices and procedures carried out by Project Teams throughout the UK MOD.
  - Review of current published UK MOD documents.
  - Review of current published International documents from agencies such as:
    - FAA
    - USAF
    - NAVAIR
    - EASA

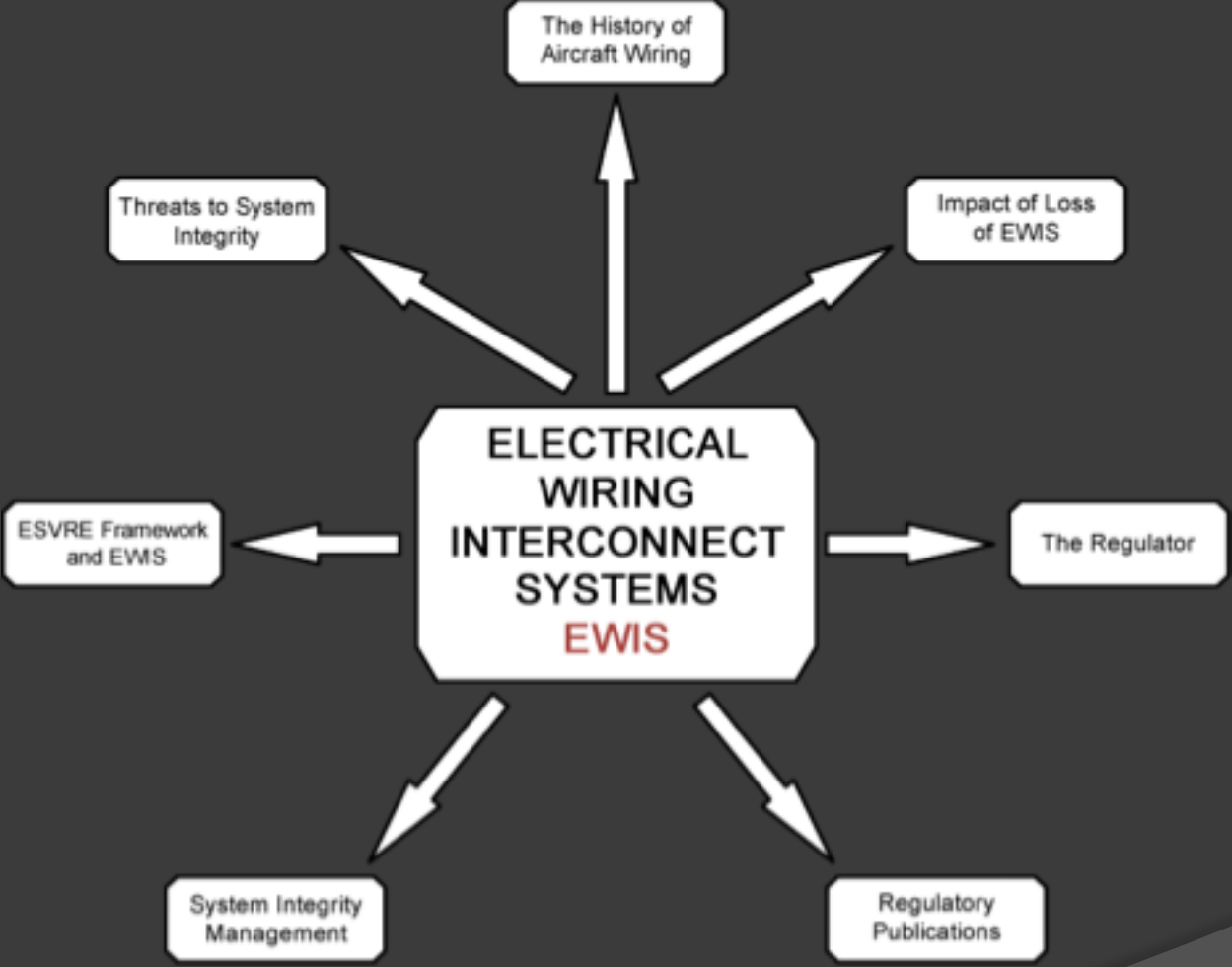
# CONSIDERATIONS

- These reviews considered, but were not restricted to the following elements:
  - Acceptance Checks
  - Through Life Management
  - In-Service Checks
  - Independent Surveys
  - Standards
  - Zonal Examinations
  - Ageing Aircraft Audits
  - Life Extension
  - Quality
  - Condition Surveys

# OUTCOME

- This phase of the EWIS C2G programme is now completed.
- 43 Page document.
- Separated in to 2 sections:
  - Electrical Wiring Interconnect System (EWIS)
  - EWIS Integrity Management

# SECTION 1





# SECTION 2





# WIMDAP

## WIRING INSULATION MATERIAL DETERIORATION ASSESSMENT PROGRAMME

### AIM

- To establish an initial baseline performance of the main in-service wire types and assess deterioration due to ageing.

### RATIONALE

- Currently no data available to show the true performance of a wire as all manufacturers testing is to a specification limit and not destruction.
- Depending on the data obtained, evidence could support platforms EWIS safety cases and Ageing Aircraft Audits.

# TEST PROGRAMME

Wire Type	Manufacturer
M22759-34-20-9	Nexans
	Judd
	TE
	RSCC

M22759/87-20-9	Carlisle
	Nexans
	Draka

M22749/187-20-9	Carlisle
	Nexans
	Draka

M81044/6-20-9	TE
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EN2667-010A006E	Carlisle
	Nexans
	Draka

DSP33/001-2T-006-1U	Brand Rex
	Habia

DSP33/001-2S-006-1U	TE
	Brand Rex
	Habia

JN1007CH006	Brand Rex
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## WIRE TYPES

- 8 Wire Types.
- 20 Wires in Total.
- Wires procured via a major distributor.
- Additional off-aircraft samples to be added where possible.
- Wires kept in a benign environment.

## TESTING

- Carried out yearly for a period of 5 years.
- Each wire tested using tests detailed in the wire type specification.
- All tests carried out to destruction.

# TESTING EXAMPLES

- Tests performed included the following:
  - Visual examination
  - Dimension Test
  - Wet Dielectric
  - Dynamic Cut Through
  - Insulation Elongation
  - Bend & Wrap Back
  - Accelerated Ageing
  - Scrape Abrasion
- Exact testing and tolerances determined by each wire types specification

# EXAMPLE RESULT

- Dynamic cut through test at  $+200 \pm 5^{\circ}\text{C}$ .



- Wire capability far exceeds the requirement.
- Results not declining with age.

# OUTCOME

- 4 out of 5 years of testing have now been completed.
- Most wires performing well against the specification and not showing a decline due to age.
- Few failures but are on tests which require temperatures that far exceed the operating temperature of the wire.
  - These high temperature ratings are being discussed in the relevant standards committees to see if they are required.
- 30 year old sample found in the MOD supply system exhibited cracking to the outer top coat lacquer when subjected to straightening/bending following life cycle testing. However, the wire sample passed all other tests.
- Once the final year of testing is complete, the full results will be published.

# QUESTIONS?