MARCH 2022

info@pacificaerotech.com.au

# C-27 SPARTAN MODIFICATION

## FUSELAGE IMPACT SHIELD

PACIFIC AEROTECH PTY LTD

# MODIFICATION OVERVIEW

The fuselage skin in-line with the propellers is prone to damage on the C-27J. The propeller-initiated damage is causing aircraft downtime and increased effort from maintenance and engineering resources.

A composite Fuselage Impact Shield will:

- **Prevent damage** to the fuselage skin.
- **Save thousands of hours maintenance and engineering** across the fleet.
- Increase aircraft availability.

The C-27J Fuselage Impact Shield is designed and manufactured in Australia.

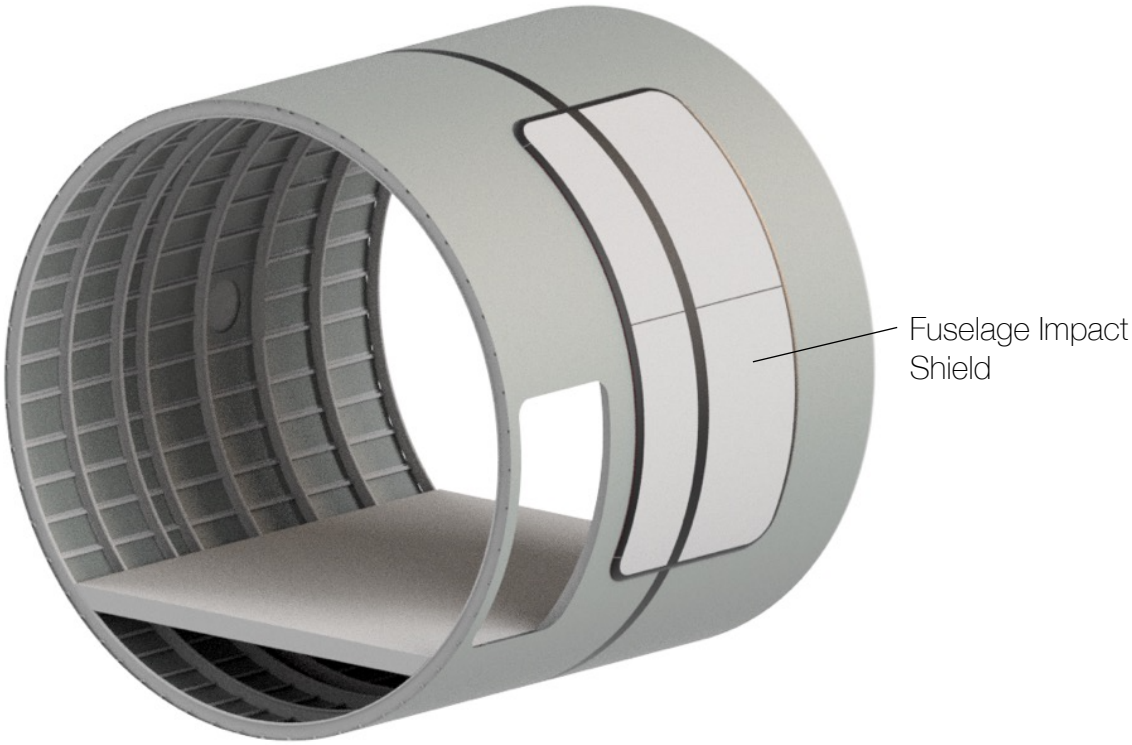
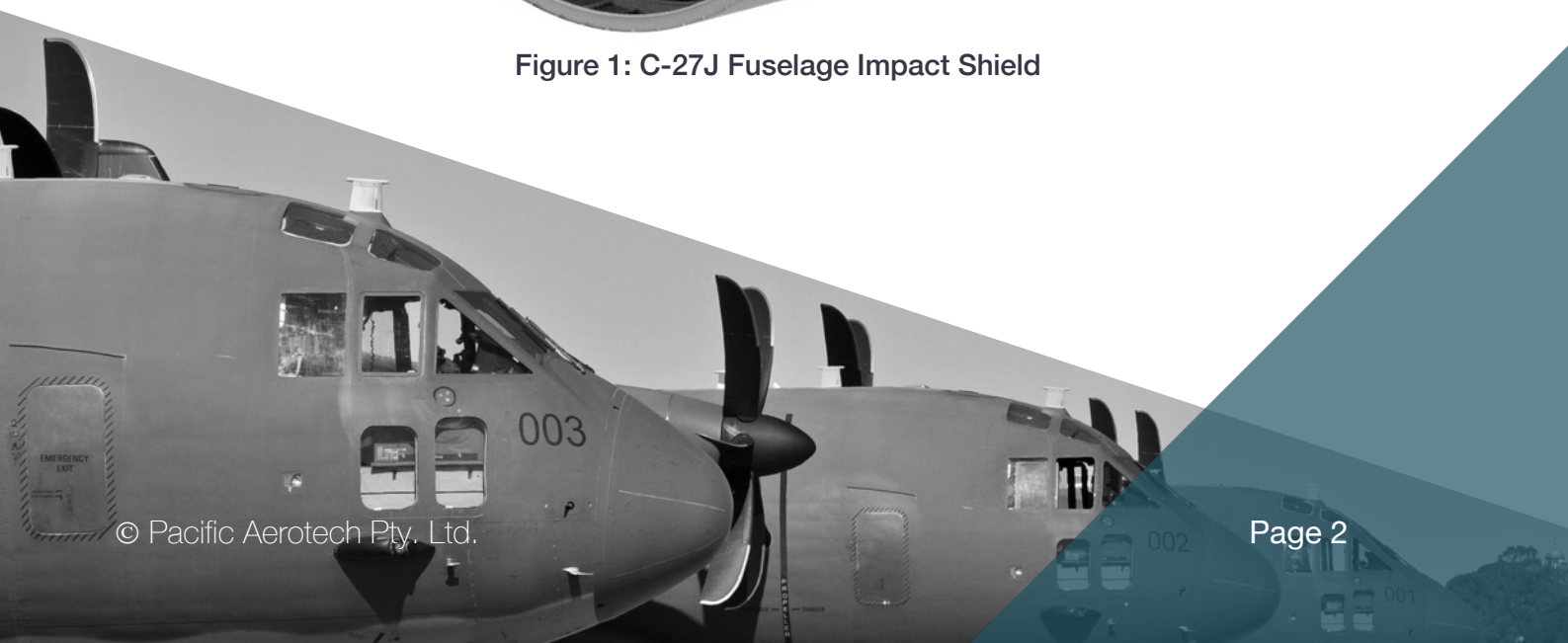



**Figure 1: C-27J Fuselage Impact Shield**



# PROBLEM: FUSELAGE DAMAGE

The C-27J fleet has experienced fuselage damage in-line with the propellers. The damage consists of dents, nicks, gouges and penetrations on both LH and RH sides of the fuselage.

The damage is frequently outside of negligible limits and requires non-standard repairs. Fuselage skin damage can result in:

- Premature cracking and 'oil canning' as a result of cyclical pressurisation loads on dents.
- Reduced fatigue life results from gouges that reduce local load carrying capacity of skin and introduces stress concentrations.

The cost of repairing damage is significant as many man-hours from maintenance and engineering are required to rectify damage. If too much damaged is sustained, replacement of the fuselage skins may be required which is costly and requires significant aircraft downtime.

The fuselage damage is a result of:

- Propeller Shedding Ice. Propeller de-ice system regularly cycles to remove ice that has formed. The ice fragments can impact the fuselage skin at 135 m/s.
- Unprepared runway operation. Operating on unsealed runways may result in stones or other debris thrown onto fuselage skin from propeller at a velocity of 220 m/s.
- Vulnerable fuselage skin. Fuselage skin is thin gauge (1mm) which doesn't resist impact.

**Figure 2: Unprepared Runway Operation**

# SOLUTION: FUSELAGE SHIELD

A shield installed on the fuselage skin prevents propeller-initiated impact damage.

### Fuselage Impact Shield Design

Two interlocking hybrid composite shields are installed each side of the fuselage:

- LH coverage: STA 6580 to STA 7900, STR 5 to STR 17.
- RH coverage: STA 6580 to STA 7900, STR 10 to 23.

The shields are moulded to match the profile of the fuselage skin and are constructed from:

- Innegra (HMPP) which provides the shield with high impact resistance (similar to Kevlar except it is hydrophobic).
- Fibreglass, provides the shield with a galvanically compatible interface and a light and durable exterior.
- Aeromesh, protects the shield from lightning strikes.

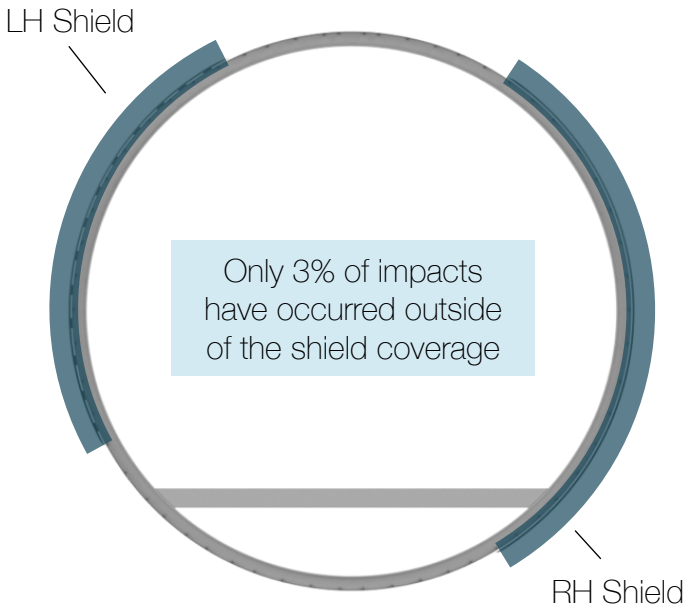



**Figure 3: Offset shield design**

### Fuselage Impact Shield Benefits

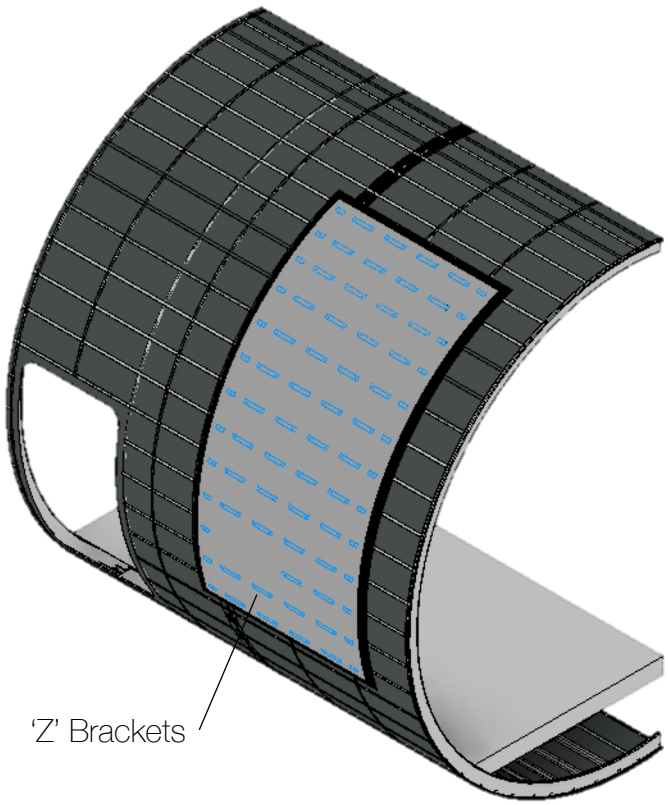
- Increase aircraft availability by preventing damage.
- Lightweight (30 kg each side)
- Interchangeable between aircraft
- Repairable by maintenance organisations using standard repair techniques.
- Two-part shield allows for simple installation and removal.

### Interface with Aircraft

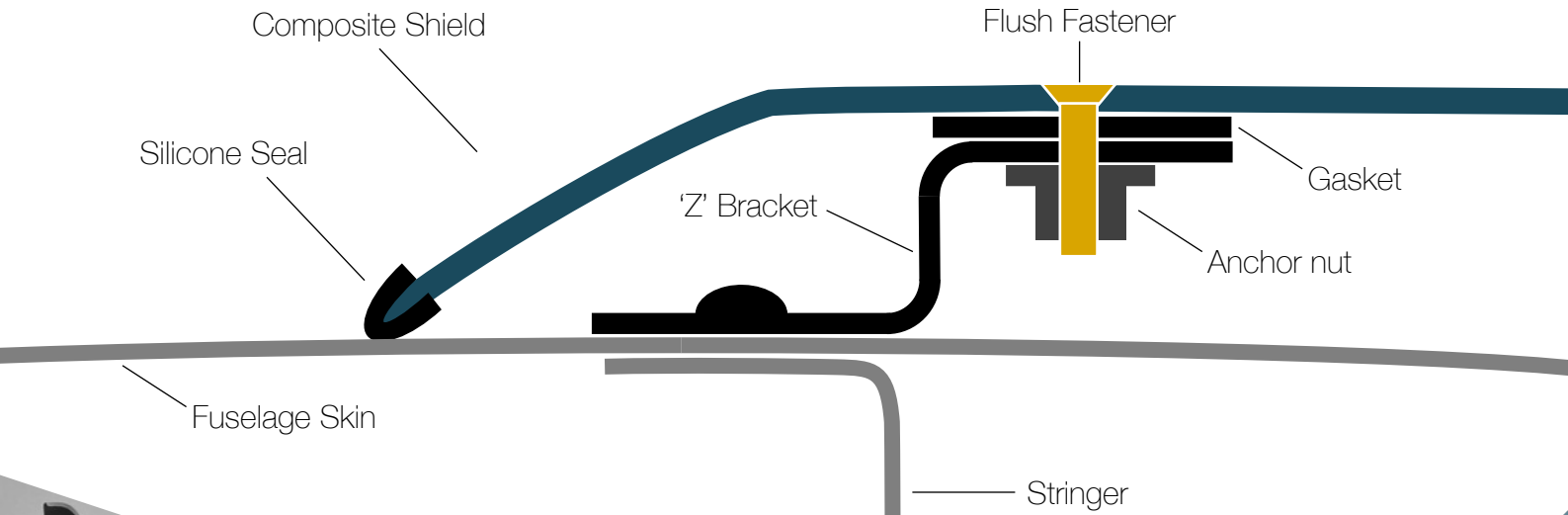
The shields are stood off the aircraft skin with aluminium 'Z' brackets. The brackets pick up on existing stringer rivets, meaning no new holes are drilled into the fuselage skin.

Anchor nuts in the brackets allow the shield to be easily installed and removed. Clearance-fit holes in the shield ensure minimal load transfer between the aircraft and the shield.

A custom silicone seal is installed around the perimeter of the shield to prevent chaffing with the fuselage skin. The seal also prevents airflow entering beneath the shield.




Shield protrudes a maximum of 25 mm from the skin




# TEST & ANALYSIS OF DESIGN

Finite Element Analysis (FEA)

- Strength of modification proven by static analysis of aerodynamic pressure and manoeuvring load cases. Analysis confirmed by static load test.
- Resonant frequency of shields avoid propeller RPM and blade passing frequencies (modal analysis).

Computational Fluid Dynamics (CFD) Analysis

- Aerodynamic effect of fuselage impact shields shown to be negligible.
- Cases analysed:
  High speed (260knots, α=2°)
  Low speed (130knots, α=13°)
  Severe sideslip (260knots, β=15°)
  Sideslip para-ops (130knots, β=8°)

Water Ingress Testing

- Testing demonstrated shield laminate does not retain water after immersion IAW MIL-STD-810G.

Material Property Testing

- Dry and Hot/Wet testing conducted on shield laminate to determine mechanical properties of material.

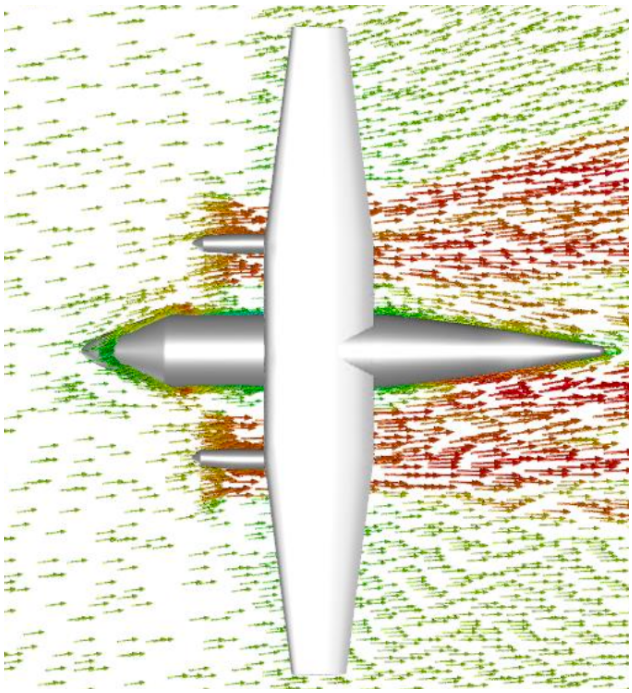


**Figure 4: CFD Analysis – Sideslip Load Case**

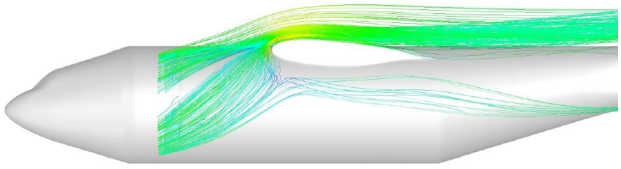


**Figure 5: Flow Streamlines – low speed, high alpha**

# IMPACT TESTING OF DESIGN

Impact testing with equivalent energy from both ice and stone impacts have been conducted to optimise protection and weight-savings.


Figure 6: Impact Test Rig

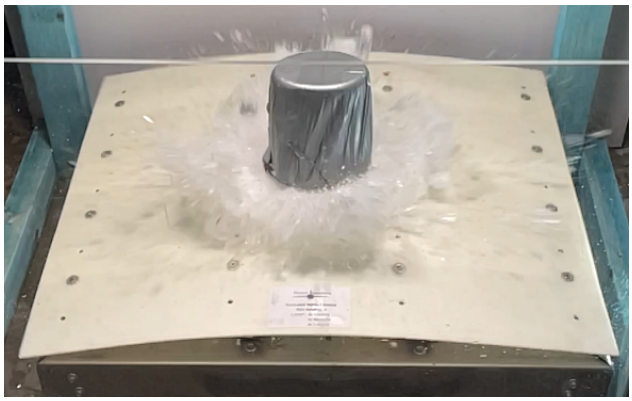
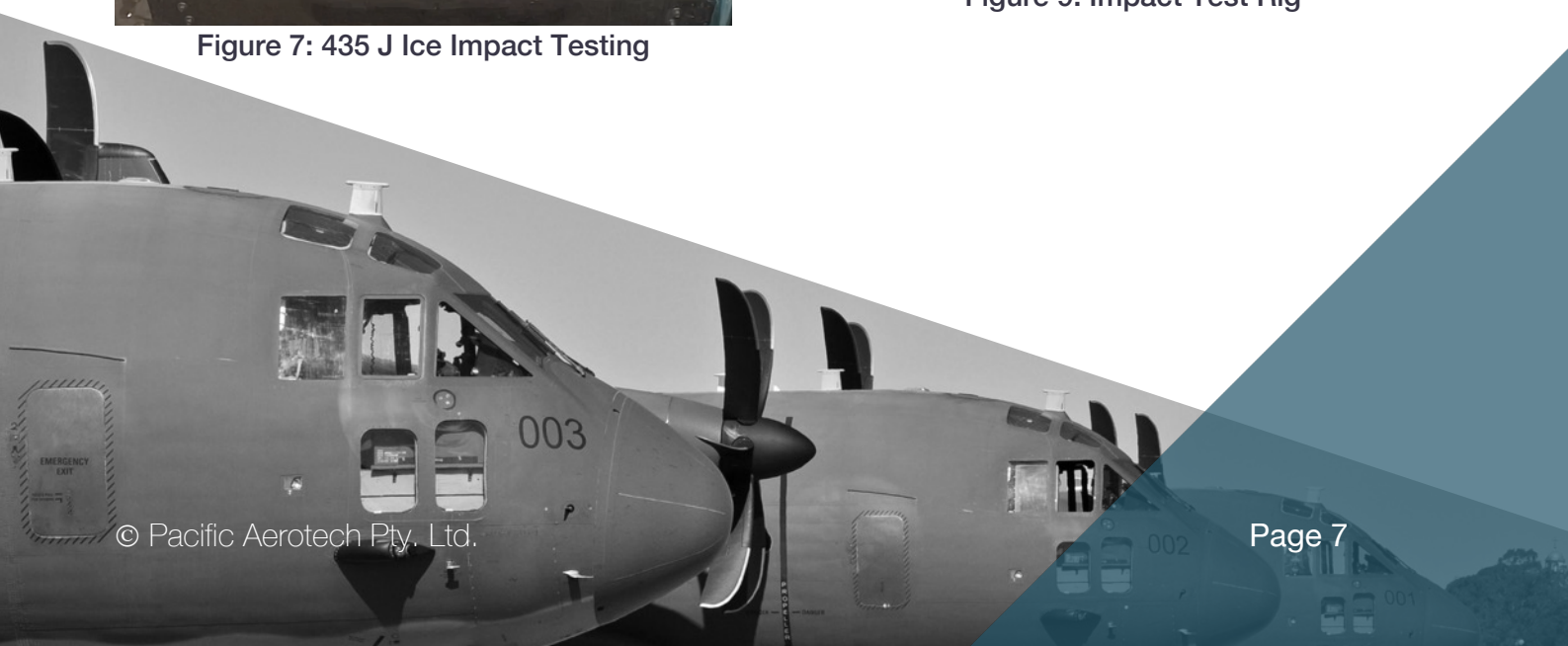


Figure 7: 435 J Ice Impact Testing

Figure 8: 72.5 J Rock Impact Testing


Figure 9: Impact Test Rig



# MODIFICATION CONTENTS

**DOCUMENTS**

- AERODYNAMICS ANALYSIS REPORT
- STRUCTURAL & VIBRATIONAL ANALYSIS REPORT
- TEST PLAN
- TEST REPORT
- COMPLIANCE REPORT
- C-27J FUSELAGE IMPACT SHIELD – STRUCTURAL REPAIR MANUAL
- C-27J FUSELAGE IMPACT SHIELD - MODIFICATION ORDER
- PUBLICATION AMENDMENTS
- MODIFICATION DRAWINGS PUBLICATION AMENDMENTS
- DESIGN CERTIFICATE

**PARTS**

4 x FUSELAGE IMPACT SHIELDS (UPR & LWR, LH & RH)

8 x SEAL, FUSELAGE IMPACT SHIELD

'Z' BRACKETS

GASKETS, 'Z' BRACKETS

HARDWARE

# CONTACT

Anthony Geoghegan
0448 369 169
ageoghegan@pacificaerotech.com.au
www.pacificaerotech.com.au

Edwin Brown
0417 245 091
ebrown@pacificaerotech.com.au
www.pacificaerotech.com.au