Electron Beam Cure Of Composite

T-38 Windshield Frame/Arch

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Overview

- **Background**
- **Frame/Arch Configuration**
- **Cure of Innerskin, Bulkhead Doubler, Fairing**
- **Cure of Outerskin/Arch**
- **Assembly**
- **Birdstrike Video**
- **Future Challenges**

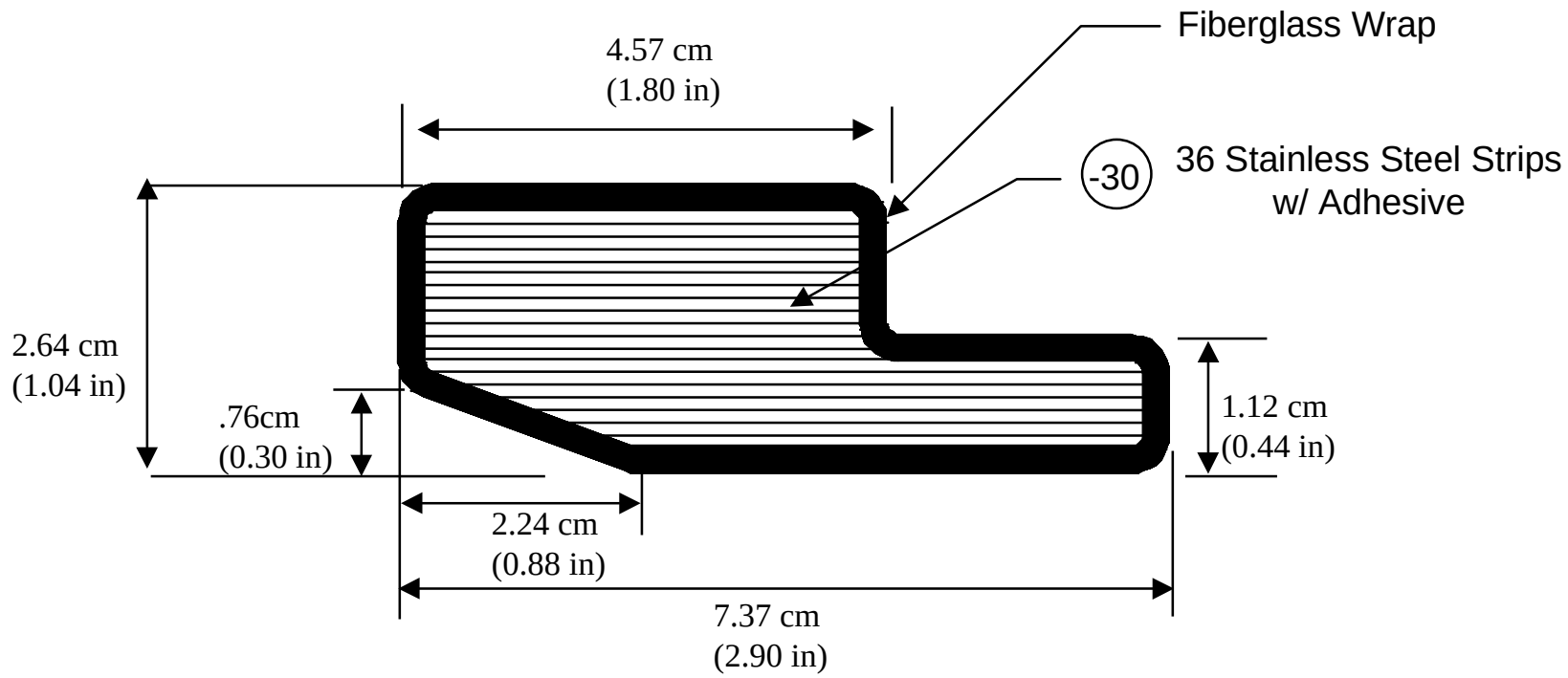
Background

- **T-38 Windshield Must Withstand The Impact Of A 1.8 kg (4 lb) Bird At 740 km/hr (400 Kts)**
- **Baseline Configuration**
  - **301 1/2 Hard Stainless Steel (AMS 5541)**
  - **Cytec Cycom 919/6781 S-Glass Epoxy**
  - **Hysol EA9628 Film Adhesive**
- **Assemblies Are Thermally Cured In An Autoclave At 121°C (250°F) And 310 kPa (90 psi)**

Frame/Arch Configuration

- **Innerskin**
  - **3.17 mm - 4.83 mm Thick (.125 in - .190 in)**
- **Bulkhead**
  - **3.17 mm (.125 in) Thick**
- **Fairing**
  - **2.03 mm - 3.56 mm Thick (.080 in - .140 in)**
- **Frame**
  - **6.5 mm (.256 in) Thick**
- **Arch**
  - **14.7 mm (.579 in) Thick Steel**
  - **1.5 mm (.059) Thick Glass Wraps**
  - **Adhesive**
  - **26.4 mm (1.04 in) Total Thickness**

Arch Cross-Section



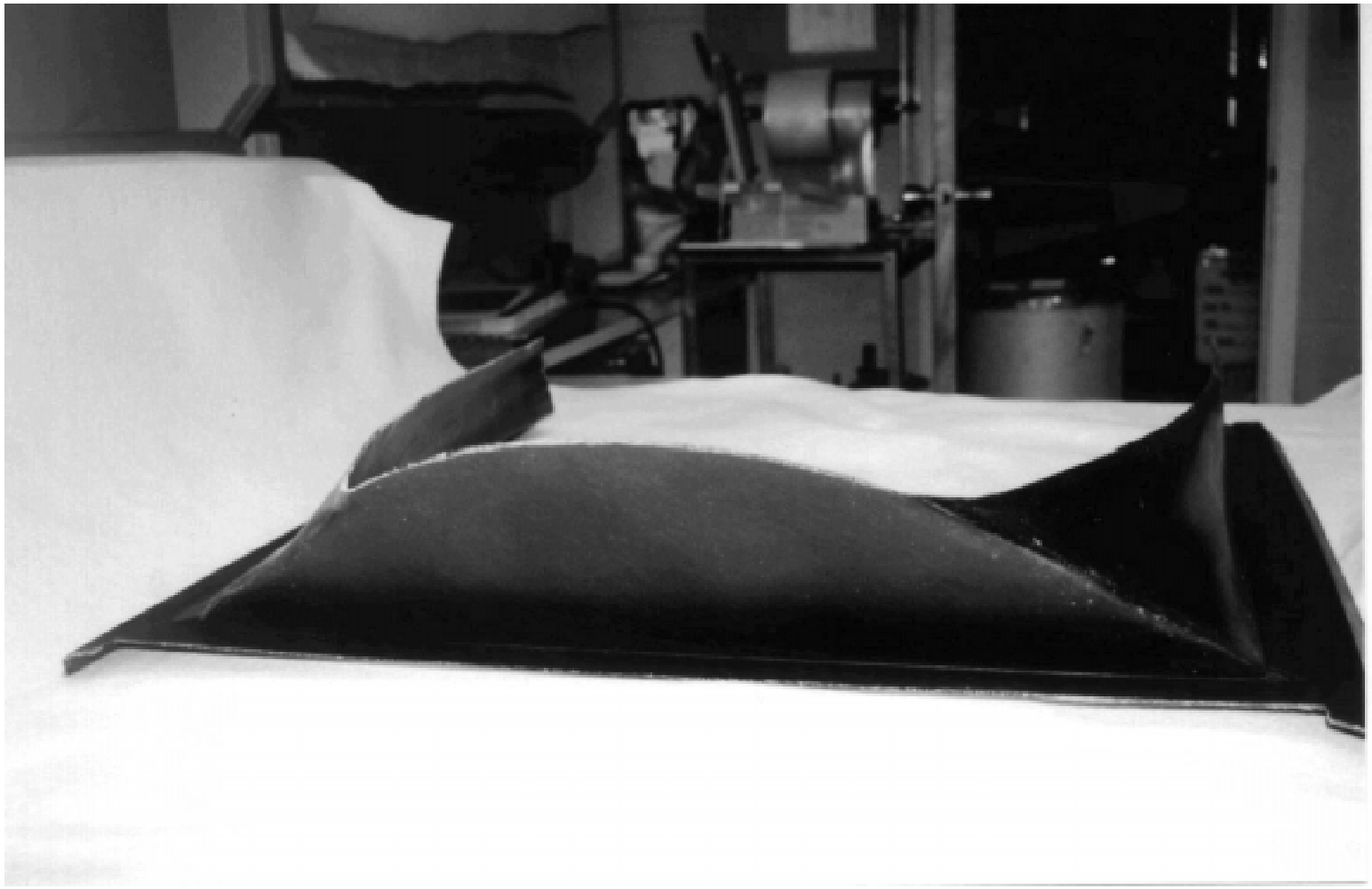
E-Beam Materials

The following Cationic Toughened Epoxies Were Used In This Program:

- **Prepreg C**
  - **Prepreged By YLA, Inc., Benica CA**
- **Paste Adhesive 11L**
- **Resins Developed By Oak Ridge And AECL**

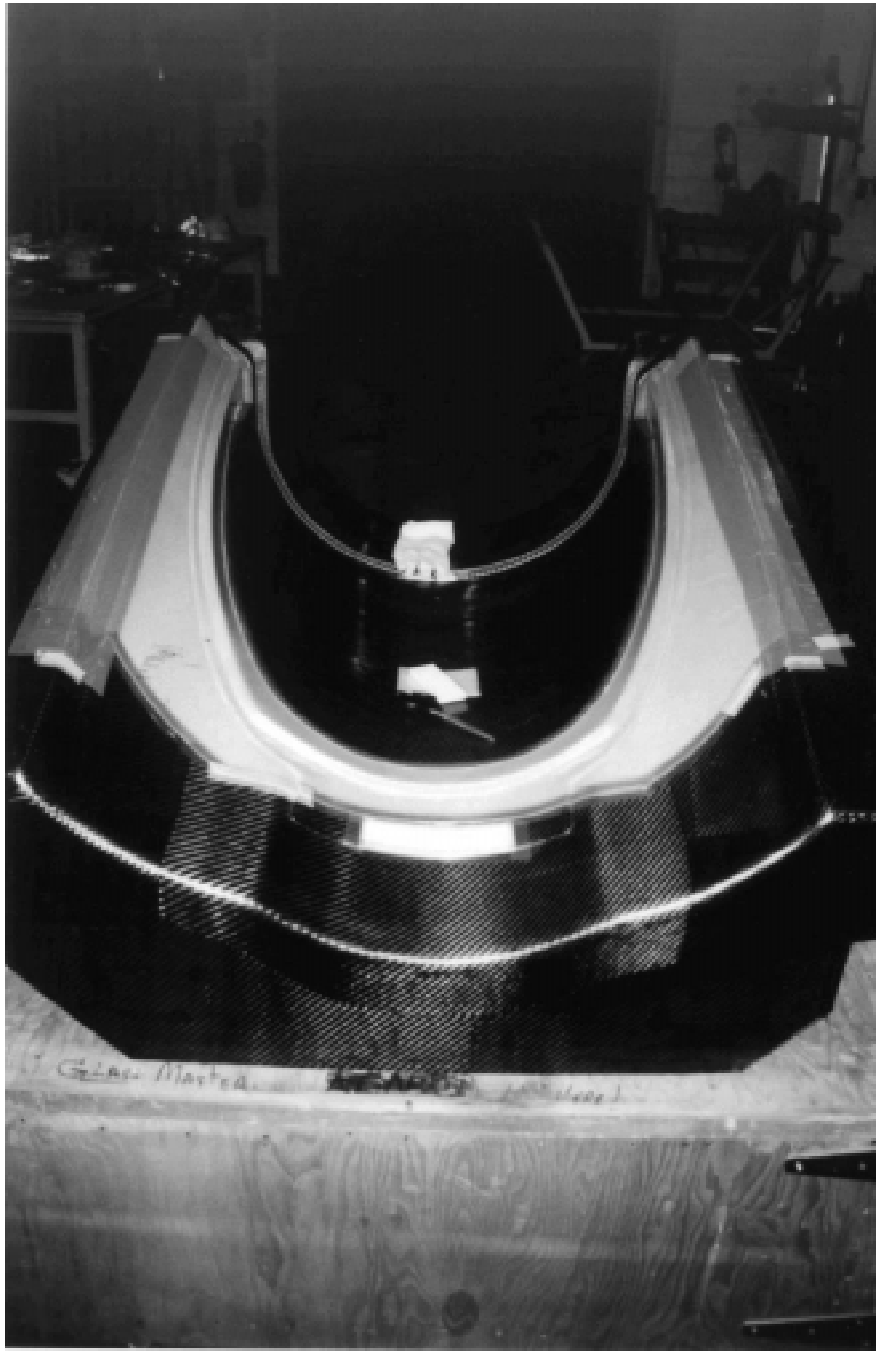
Manufacture of Innerskin, Bulkhead Doubler, Fairing

- **Structures Laid Up At AECL By USAF Mechanics**
- **Used Vacuum Only For Compaction Pressure**
- **Test Program Determined A Desired Dose Of 150 kGy**
- **1 kW E-Beam Facility**
- **Cure Times**
  - **Bulkhead: 1 Hr**
  - **Fairing: 2 Hrs**
  - **Innerskin: 3 Hrs**

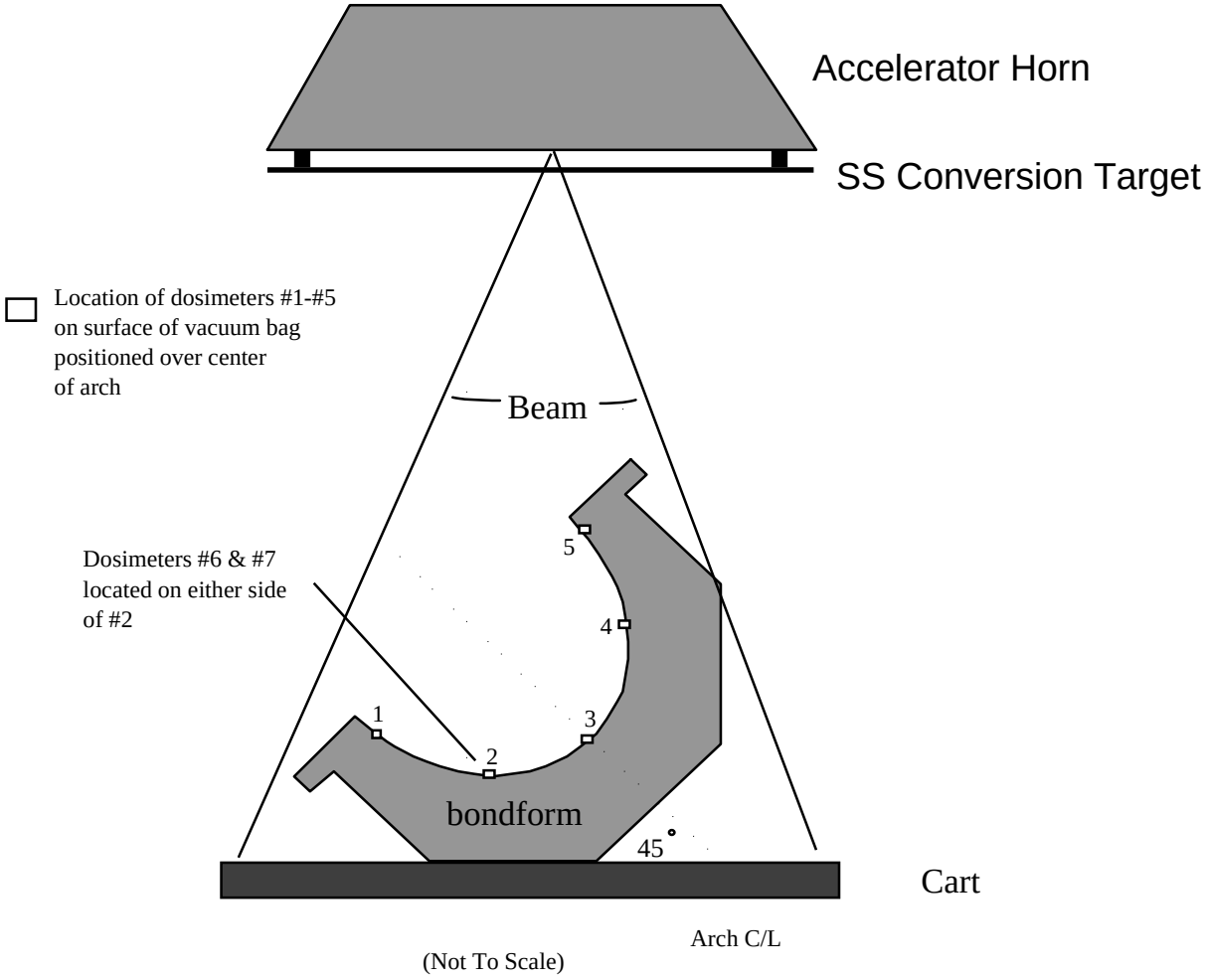


Manufacture Of Outerskin/Arch

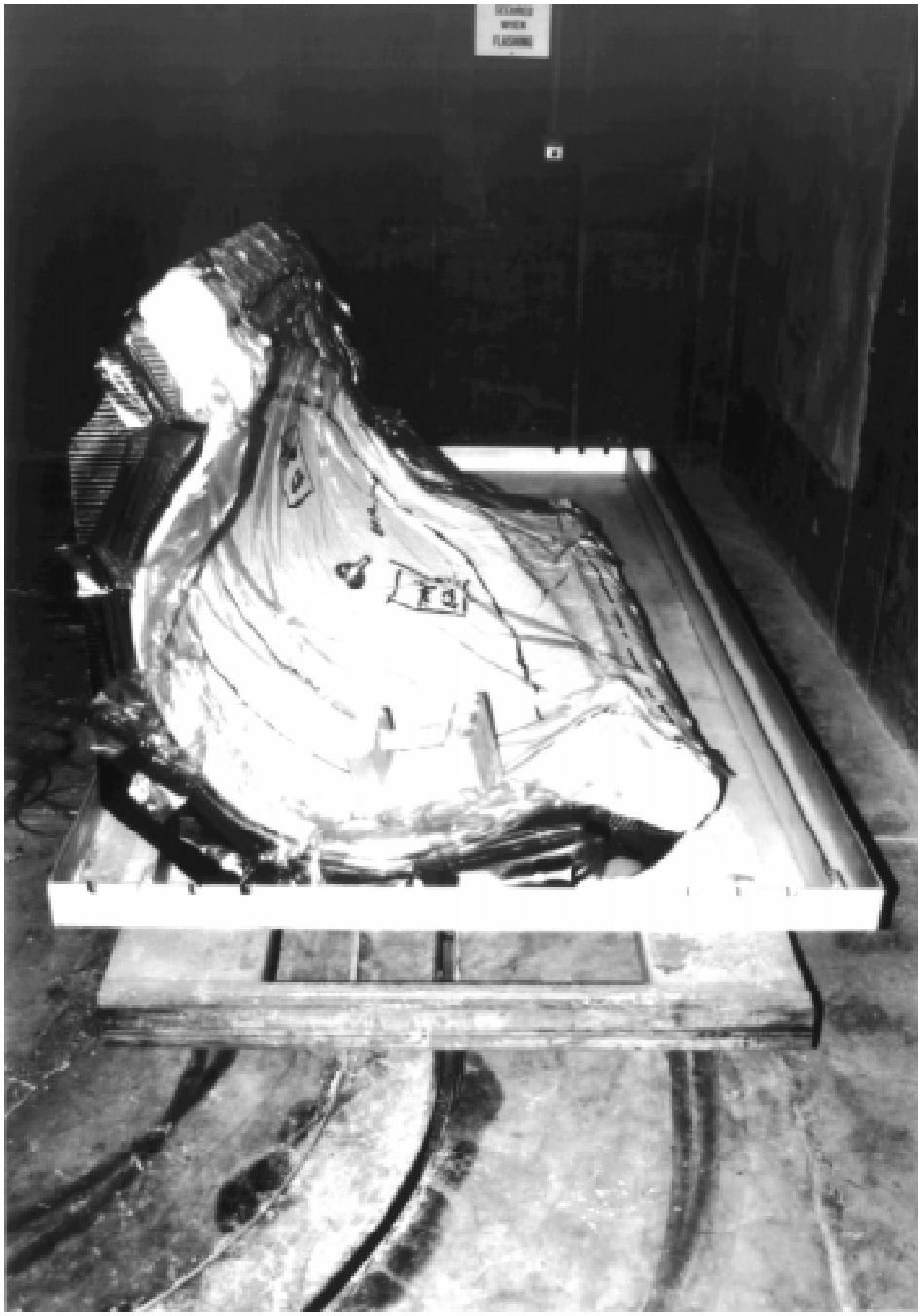
- **Structure Laid Up At McGuire AFB, NJ By USAF Mechanics**
- **Used Vacuum Only For Compaction Pressure**
- **Cured At 50 kW at E-Beam Services, Cranbury, NJ**
- **E-Beam Used To Cure Outerskin**
- **X-Ray Required To Penetrate Steel To Cure Adhesive In Arch**
- **Cure Time**
  - **5.5 Hrs Over 4 Stages**



Cure Set-Up



X-ray Cure Set-Up

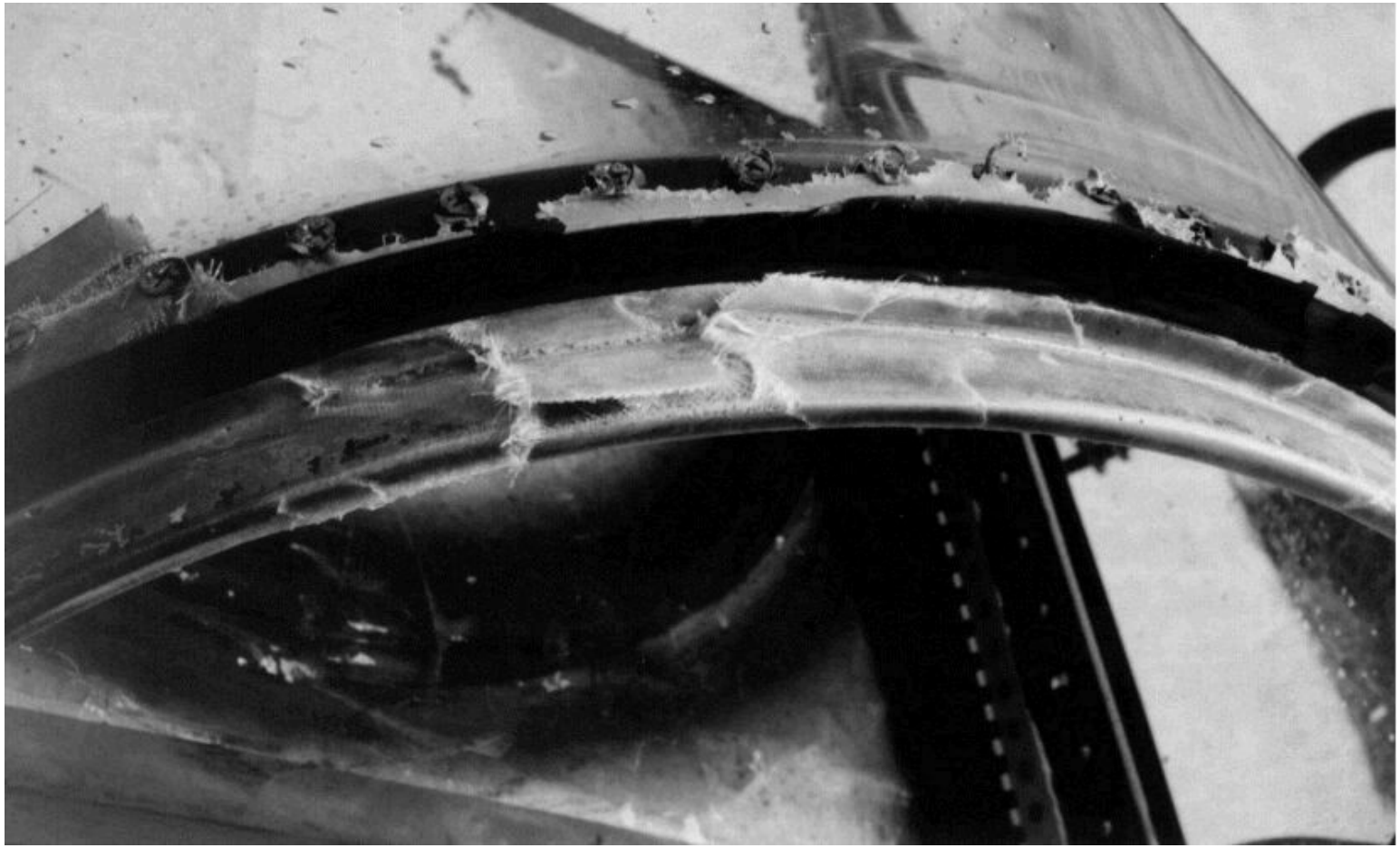


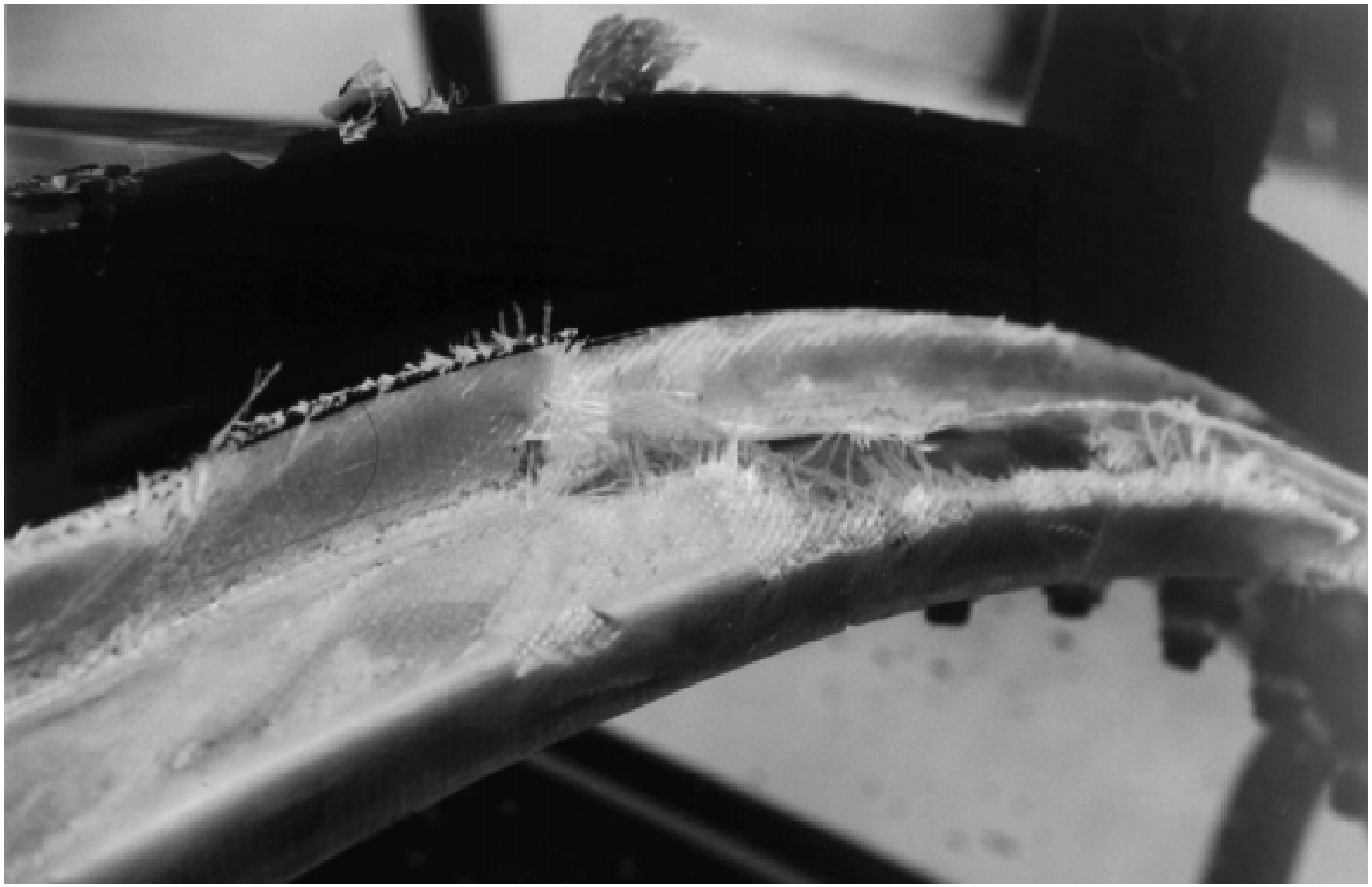
Assembly

Final Assembly Of The Components Took Place At McClellan AFB Using Baseline Thermally-Cured Epoxy

- **Not Considered Critical Since All Bondlines Have Fasteners To Attach Other Hardware**
- **Note: Mechanics Noted That Structure Locally Delaminated When Fastener Holes Drilled**

Bird Strike Video





Future Challenges

- **Develop Prepregs With Better Interlaminar Properties, Toughness**
- **Develop Film Adhesive**
- **Explore High Temperature Possibilities**