



# Structural Metal Bonding At Cessna Aircraft

## Discussion Points

- **Cessna Experience**
- **Metal Bonding Process**
- **Process Control Philosophy**
- **Risk and Risk Mitigation**
- **Conclusions**

## Cessna Experience

- **1960s - Secondary structure**
- **1970s - Primary structure, integral fuel tanks**
- **1980s - Fully bonded airframe**
- **40 Years Experience and 6000+ airplanes**

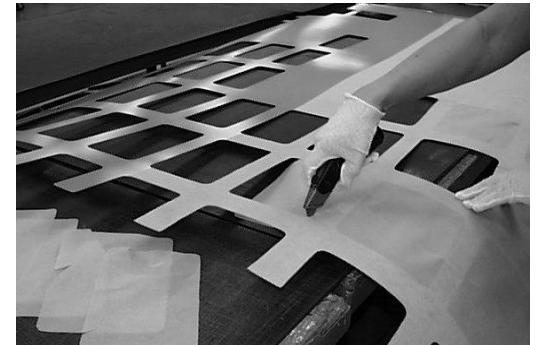
## Metal Bonding Process



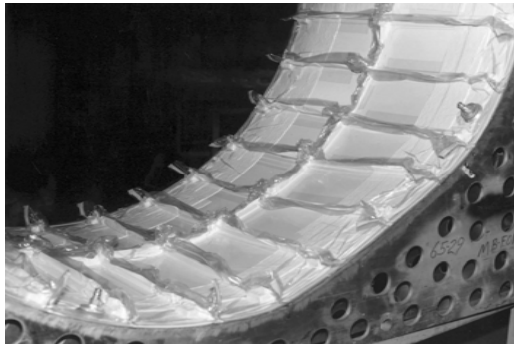
Phosphoric acid anodize



Bond primer application



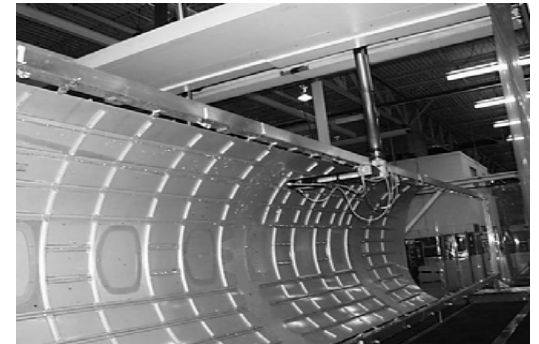
Lay-up



Bagging and tooling



Autoclave cure



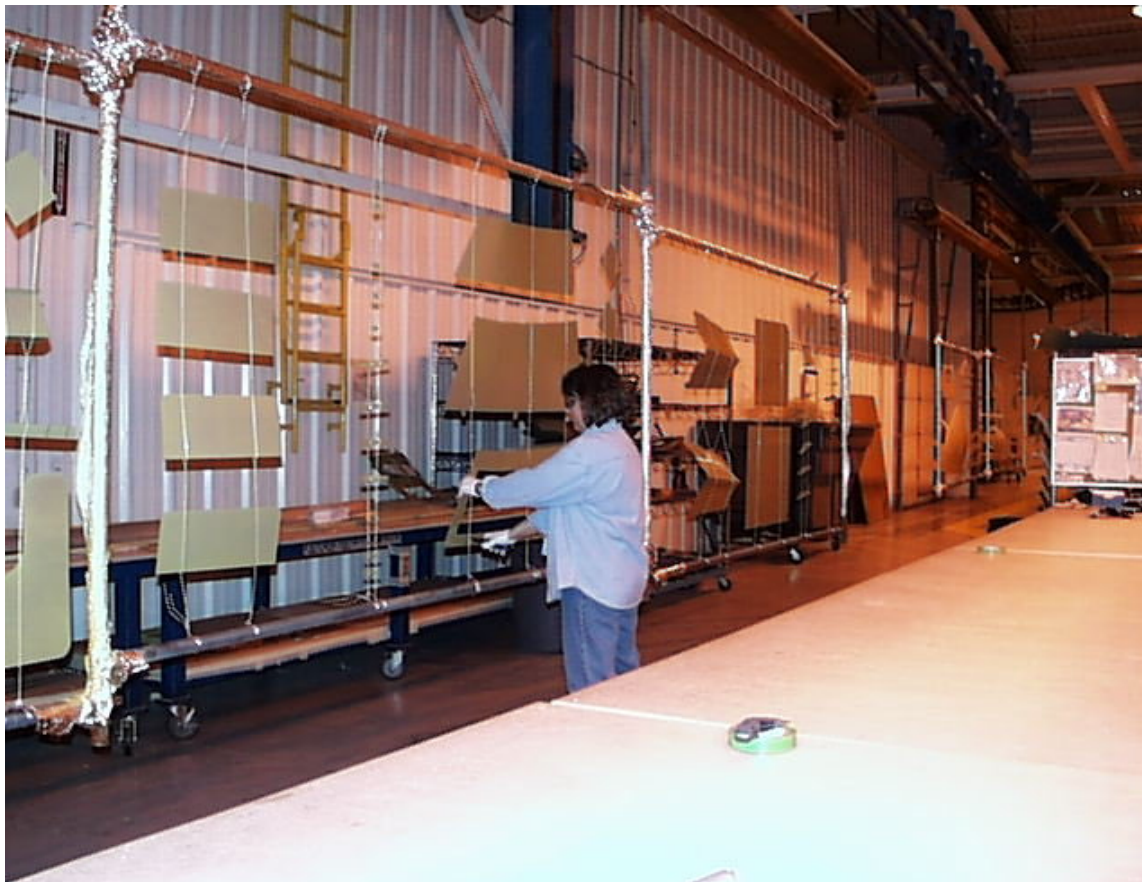
Post-cure inspection

## Phosphoric Acid Anodize



- Automated process line
  - Clean, rinse, PAD, rinse, PAA, rinse, dry
- Rate issues
  - Surface cleaning, water quality, solution aging
- Process control
  - Data acquisition of spec parameters: temp, time, voltage, current
  - Water break inspections
  - Current draw inspection
  - Wedge crack extension
  - Surface morphology
  - Periodic training

## Bond Primer Application



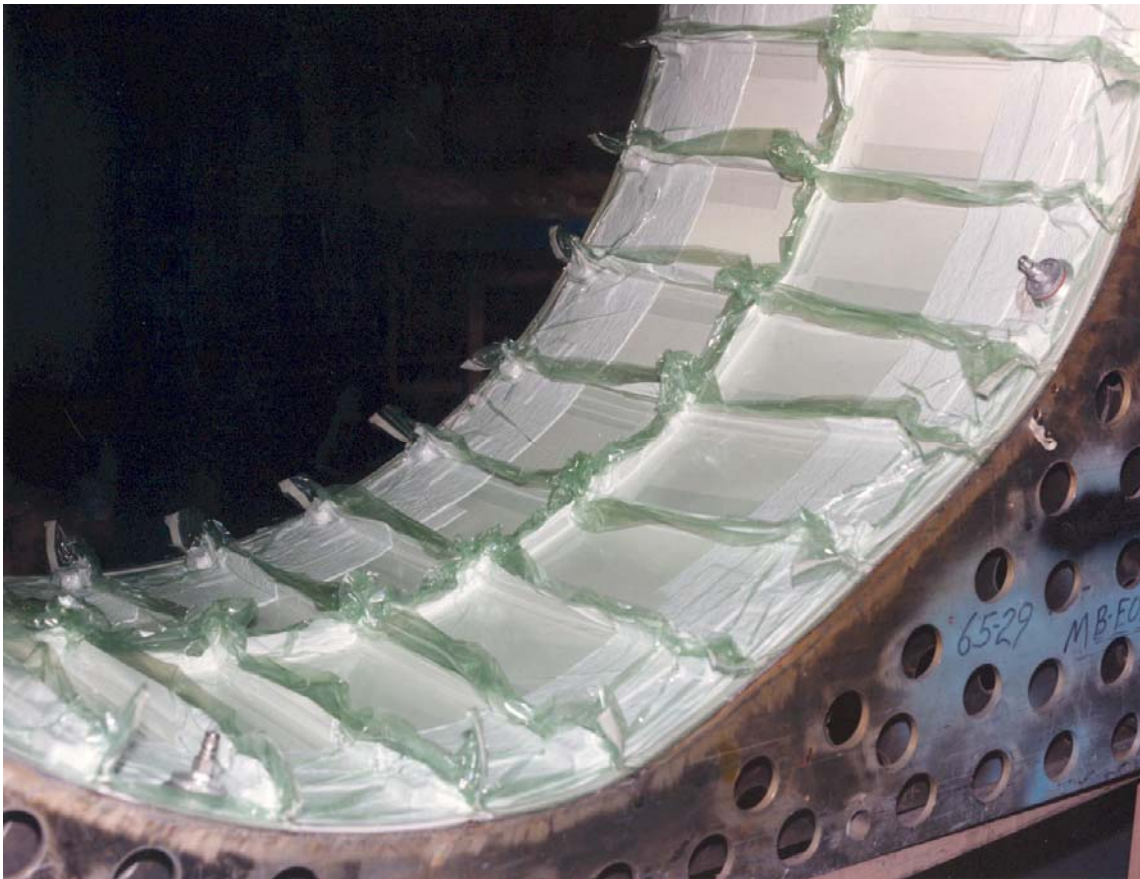
- Manual airless spray
  - Inspect, spray, flash, cure, inspect
- Rate issues
  - Environment control, primer agitation, operator training
- Process control
  - Data acquisition of spec parameters: time, temp, RH, monitoring of air quality
  - Visual, polarized filter
  - Period operator quals
  - Visual and thickness
  - Wedge crack extension

## Lay-up



- Adhesive application
  - Inspect, cut, apply, inspect, assemble
- Rate issues
  - Environment control, fit checks, operator training,
- Process control
  - Recording of spec parameters: temp, RH, air quality, Out-time-tracking
  - Buddy check for paper
  - Visual
  - Shop instructions
  - Controlled expendables

## Bagging and Tooling



- Bagging
  - Breather, sealant, bag, vacuum check
- Rate issues
  - Operator training, tool maintenance
- Process control
  - Spec parameters: leak rate

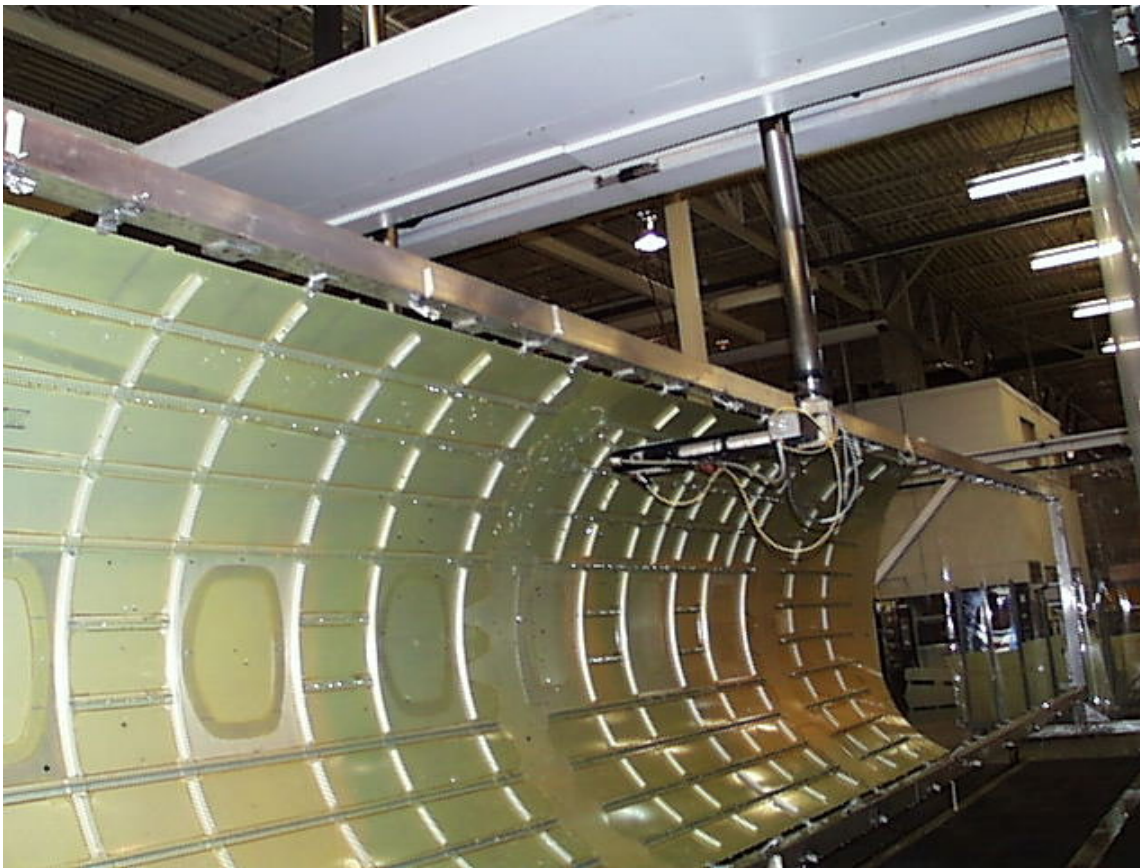


## Autoclave Cure



- Cure cycle
  - Load, instrument tools, leak check, start cycle, unload, debug, deflash
- Rate issues
  - Tool maintenance
- Process control
  - Data acquisition of spec parameters: temp, pressure, time, leak rate
  - Periodic shear and peel tests

## Post-Cure Inspection



- Inspection
  - Visual for FOD and other anomalies, ultrasonic inspection
- Rate issues
  - Operator training
- Process control
  - Technician certification
  - Standards and calibration
  - Initial process qualification and subsequent requalifications for each bond assembly

## Process Control Philosophy

**“End of Process” inspection alone  
is insufficient for assuring structural integrity.**

## Risk

- **A structural delamination and/or a bond failure can result in:**
  - **Safety issues**
  - **Customer dissatisfaction**
  - **Loss of confidence**
    - **Customers**
    - **FAA, other regulatory authorities**
  - **Degradation of reputation and Brand**
  - **Product liability (financial)**

## Risk Mitigation

- **Process Control Mentality**
  - **Specification adherence**
  - **In process monitoring**
  - **Personnel training and qualification**
  - **NDI**
  - **Initial assembly qualification and subsequent requalifications**
  
- **Proper Facilities and Equipment**
  - **Process line design and control**
  - **Tooling design and maintenance**
  - **Autoclave design and control**

## Risk Mitigation

- **Experienced and knowledgeable staff**
  - **Manufacturing and Facilities**
  - **Quality and Inspection**
  - **M&P and other Engineering**
  
- **Process and product improvements as a result of field experience – Lessons Learned**

## Conclusions

- **Benefits outweigh the risks if properly managed**
  - **Documented and audited processes**
  - **Process control mentality**
  - **Proper facilities and equipment**
  - **Active maintenance programs**
  - **Experienced staff that understands:**
    - **How to do it**
    - **Why they are doing it**