



# Cessna Bonding Experience

An Overview of 40 Years of Experience

## Cessna Experience

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

## What is Primary ?

- **Doublers bonded to skins**
- **Ribs, rib caps, and frames bonded to doublers/skins**
- **Stringers bonded to doublers/skins**
- **Spar assemblies (webs and caps)**
- **Engine beam assemblies**
- **Flight control surfaces**

## **Critical Safety Issues and/or Certification Considerations**

- **Joint design and durability**
  - **Corrosion**
  - **Allowables**
  
- **Manufacturing defects**
  - **Those that can be inspected and quantified**
    - **Voids**
    - **Thickness**
  - **Those that are difficult to quantify**
    - **Oxide integrity**
    - **Surface contamination**

## **Single and Twin, Piston Engine Aircraft Twin Engine Turboprop ~ 1970 to Present**

- **Clad alloys**
- **Acid etch surface treatment**
- **Chromate bond primer**
- **Paste and film adhesives**
- **Primarily mechanical pressure  
or vacuum bag, oven cure, some autoclave**

Cessna  
1981 MODEL **340A**

**AIRFOILS**

**WING**

- ◻ AIRCRAFT MACA 23018 MODIFIED
- ◻ MACELLE MACA 23015 MODIFIED
- ◻ TIP MACA 23009 MODIFIED

**TAIL (VERTICAL)**

- ◻ ROOT (LESS DORSAL) MACA 0009 MODIFIED
- ◻ TIP MACA 0006 MODIFIED

**TAIL (HORIZONTAL)**

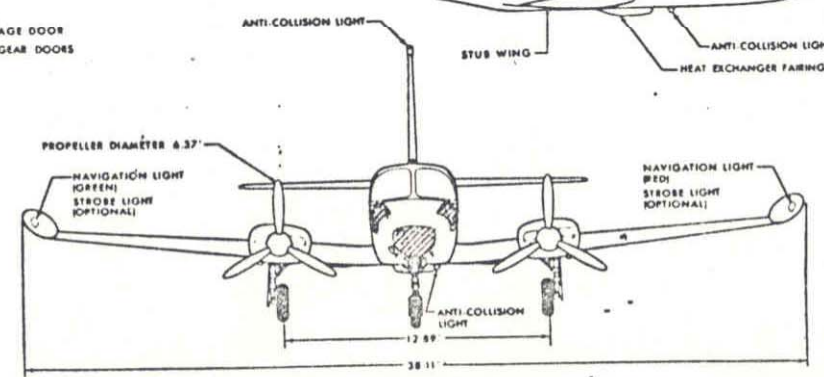
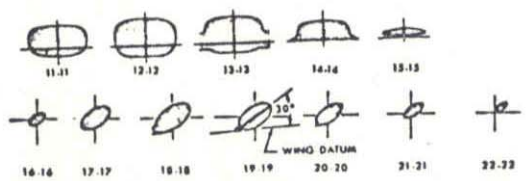
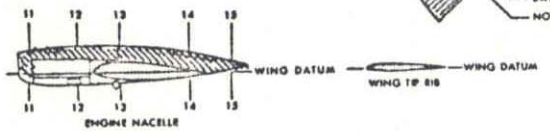
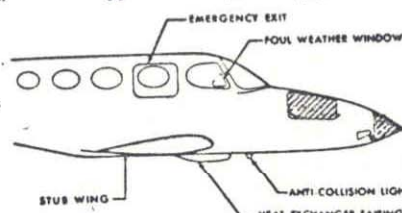
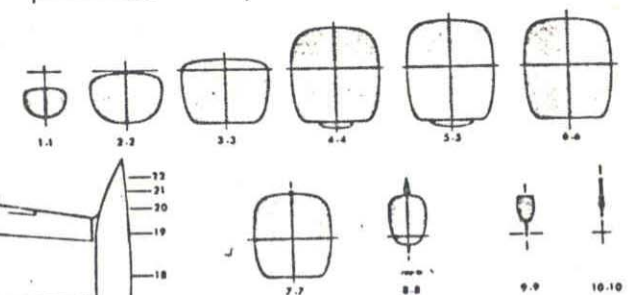
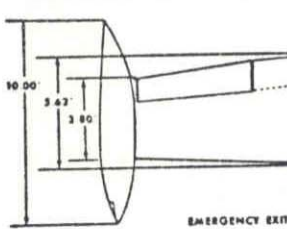
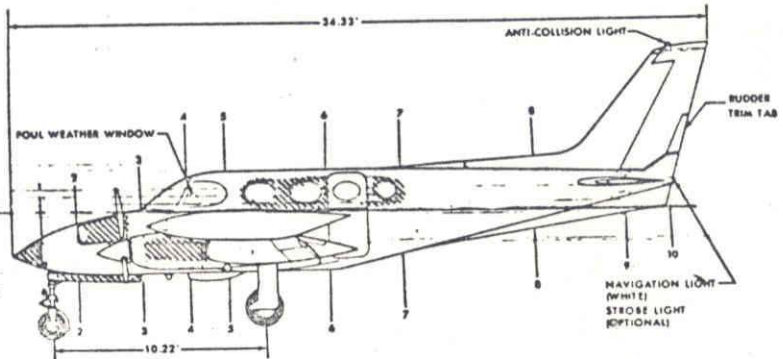
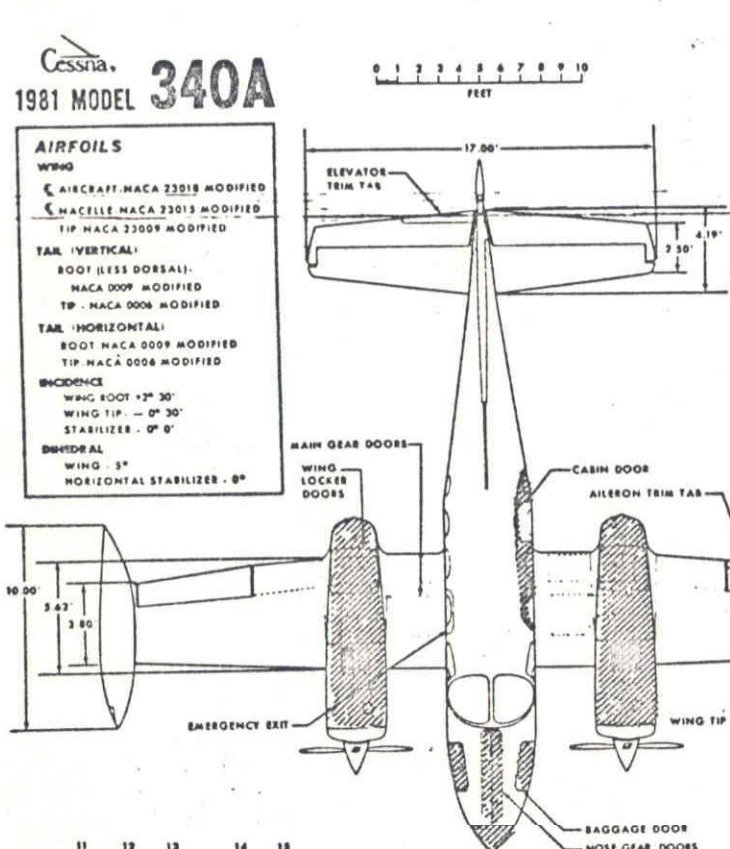
- ◻ ROOT MACA 0009 MODIFIED
- ◻ TIP MACA 0006 MODIFIED

**INCIDENCE**

- ◻ WING ROOT +2° 30'
- ◻ WING TIP - 0° 30'
- ◻ STABILIZER - 0° 0'

**DIHEDRAL**

- ◻ WING 5°
- ◻ HORIZONTAL STABILIZER - 0°





Cessna  
1981 MODEL 402C

**AIRFOILS**

**WING**

AIRCRAFT-NACA 23018 MODIFIED  
MACELLE-NACA 23013 MODIFIED  
TIP-NACA 73009 MODIFIED

**TAIL (VERTICAL)**

ROOT (LESS DORSAL)-  
NACA 0012 MODIFIED  
TIP-NACA 0009 MODIFIED

**TAIL (HORIZONTAL)**

ROOT-NACA 0009 MODIFIED  
TIP-NACA 0006 MODIFIED

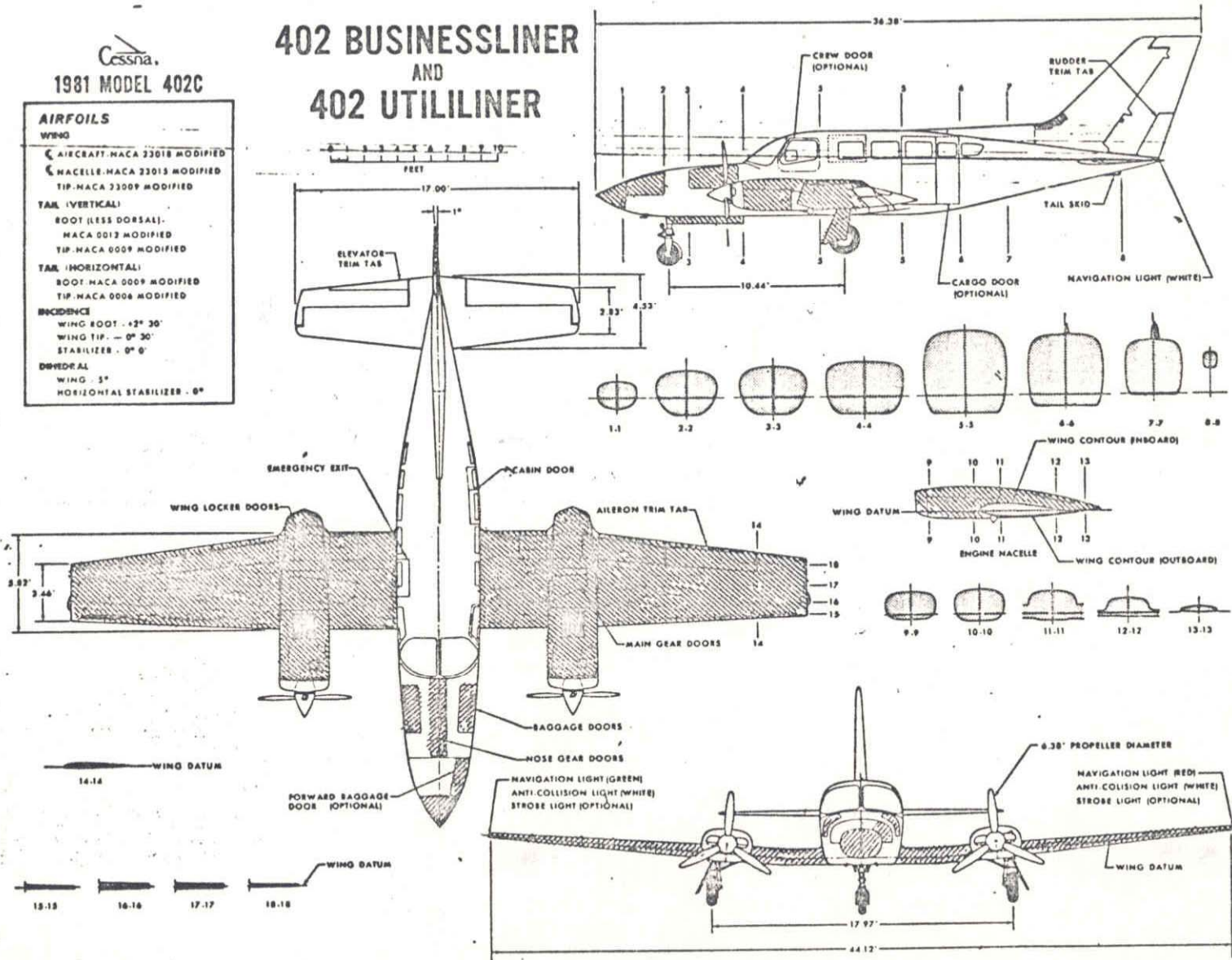
**INCIDENCE**

WING ROOT - +2° 30'  
WING TIP - 0° 30'  
STABILIZER - 0° 0'

**DIVEDRAL**

WING - 3°  
HORIZONTAL STABILIZER - 0°

# 402 BUSINESSLINER AND 402 UTILILINER



Cessna  
1981 MODEL 421C

# 421 GOLDEN EAGLE

**AIRFOILS**

**WING**

AIRCRAFT-NACA 23018 MODIFIED  
 HACCLE-NACA 23013 MODIFIED  
 TIP-NACA 23009 MODIFIED

**TAIL (VERTICAL)**

ROOT (LESS DORSAL)-  
 NACA 0012 MODIFIED  
 TIP-NACA 0009 MODIFIED

**TAIL (HORIZONTAL)**

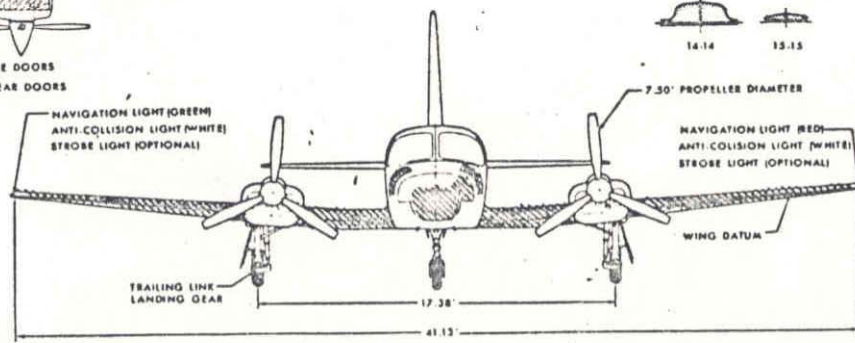
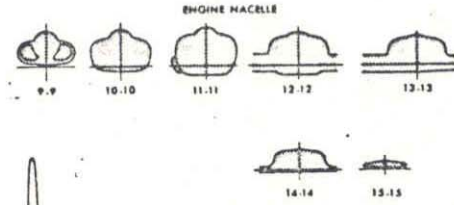
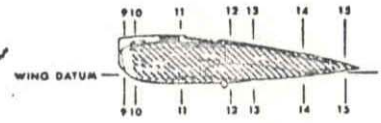
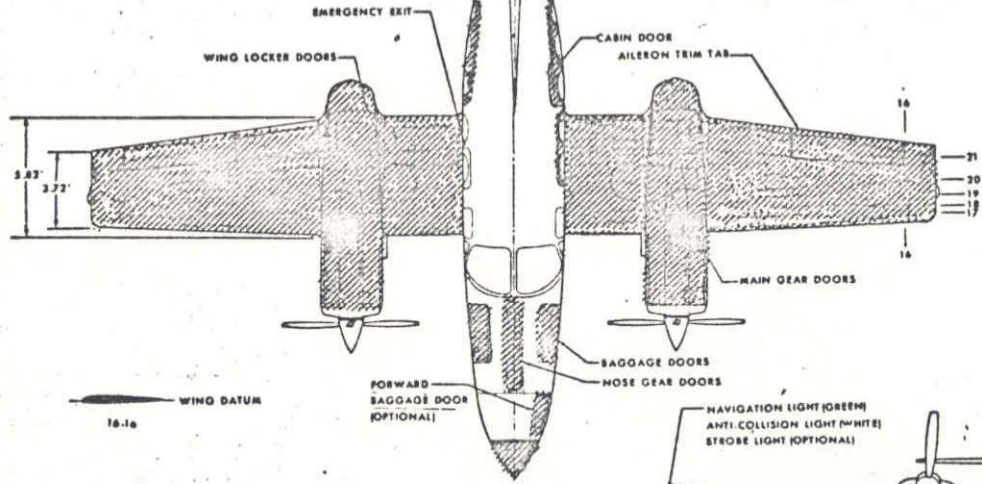
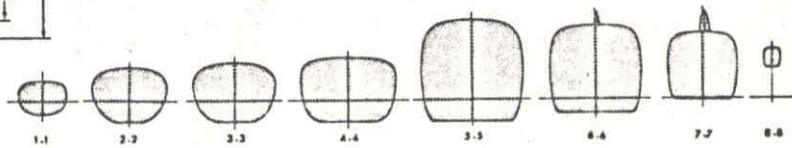
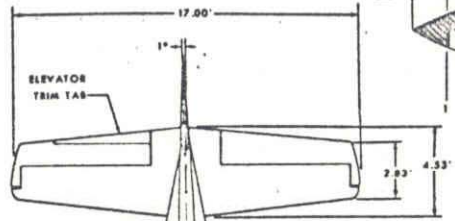
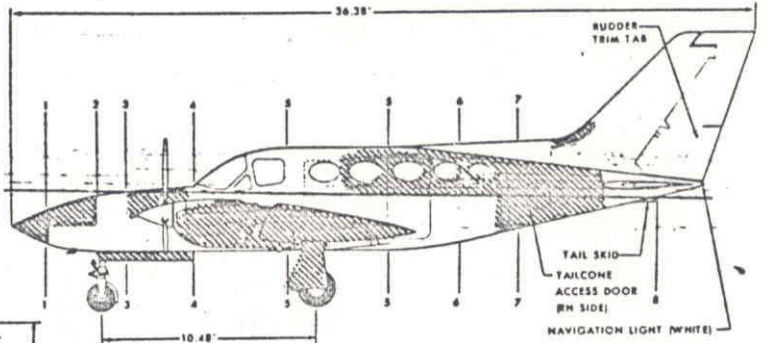
ROOT-NACA 0009 MODIFIED  
 TIP-NACA 0008 MODIFIED

**INCIDENCE**

WING ROOT -  $+2^{\circ} 30'$   
 WING TIP -  $0^{\circ} 30'$   
 STABILIZER -  $0^{\circ} 0'$

**DIHEDRAL**

WING -  $5^{\circ}$   
 HORIZONTAL STABILIZER -  $0^{\circ}$





Cessna  
1981 MODEL 414A

**AIRFOILS**

**WING**

- ☒ AIRCRAFT-NACA 23018 MODIFIED
- ☒ MACELLE-NACA 23013 MODIFIED
- TIP-NACA 23009 MODIFIED

**TAIL (VERTICAL)**

- ☒ ROOT (LESS DORSAL)-NACA 0012 MODIFIED
- TIP-NACA 0009 MODIFIED

**TAIL (HORIZONTAL)**

- ☒ ROOT-NACA 0009 MODIFIED
- TIP-NACA 0008 MODIFIED

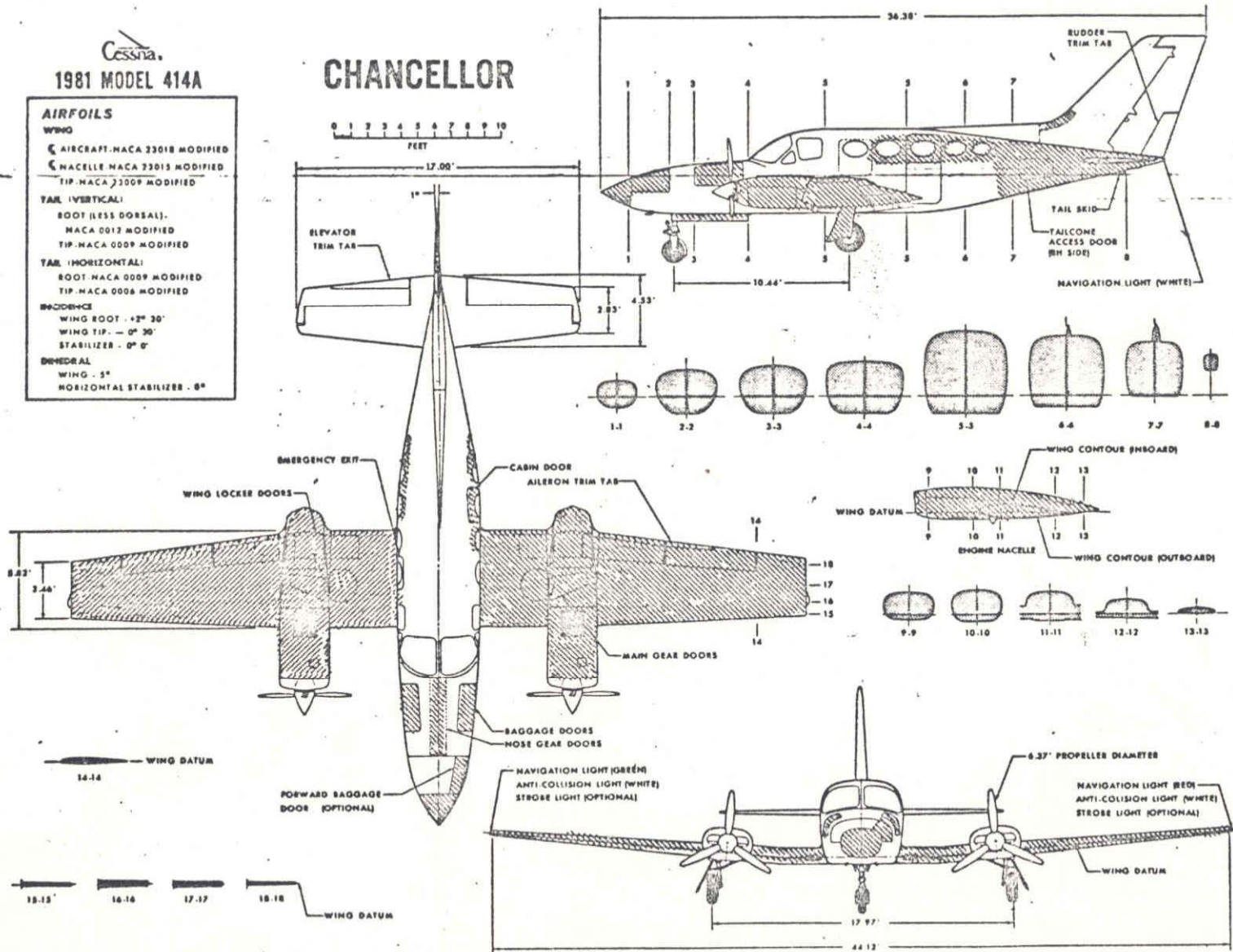
**INCIDENCE**

- WING ROOT - +2° 30'
- WING TIP - 0° 30'
- STABILIZER - 0° 0'

**DIBEDRAL**

- WING - 5°
- HORIZONTAL STABILIZER - 8°

**CHANCELLOR**





1981 MODEL 404

**AIRFOILS**

**WING**

CENTER WING: MACA 23018  
CONSTRUCTION TIP: MACA 33018

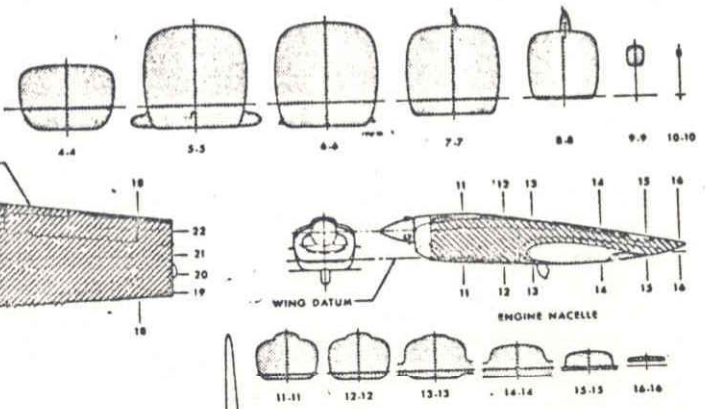
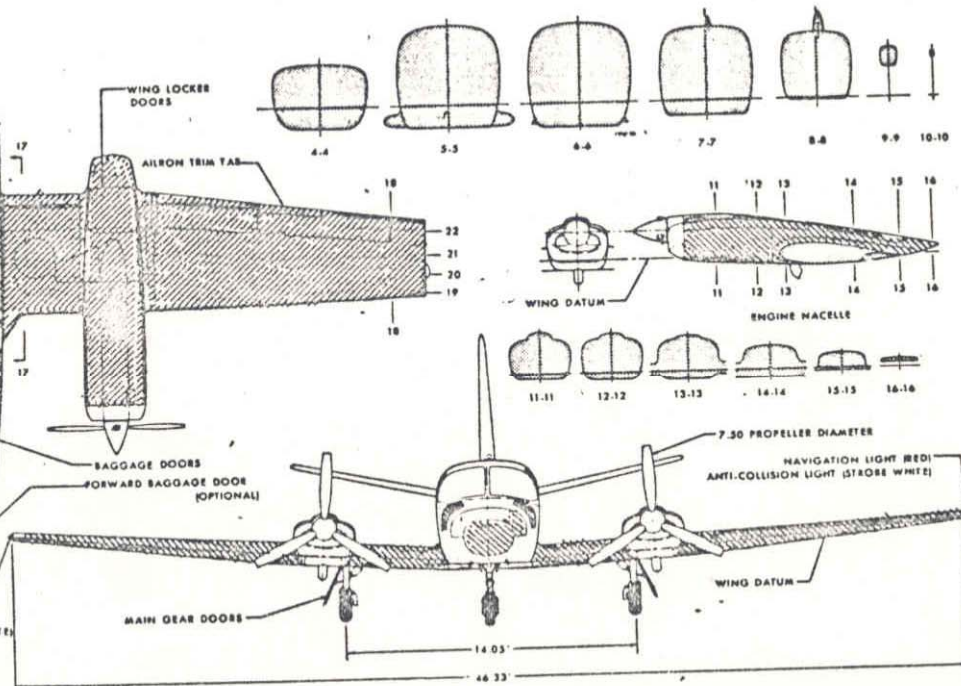
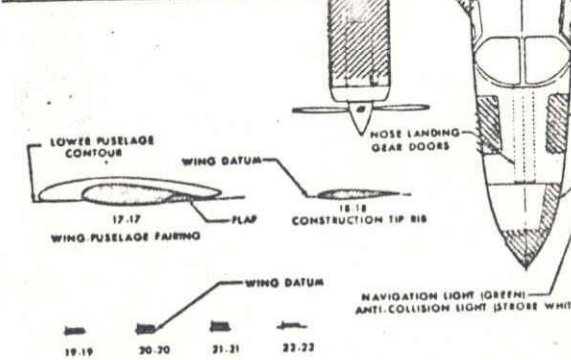
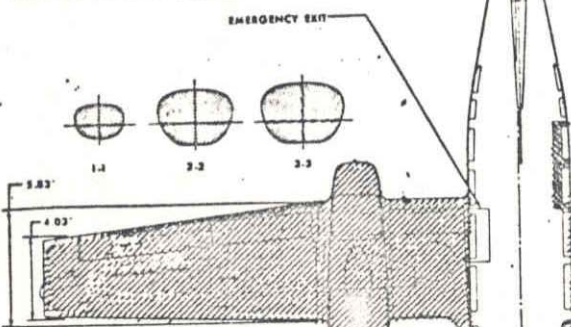
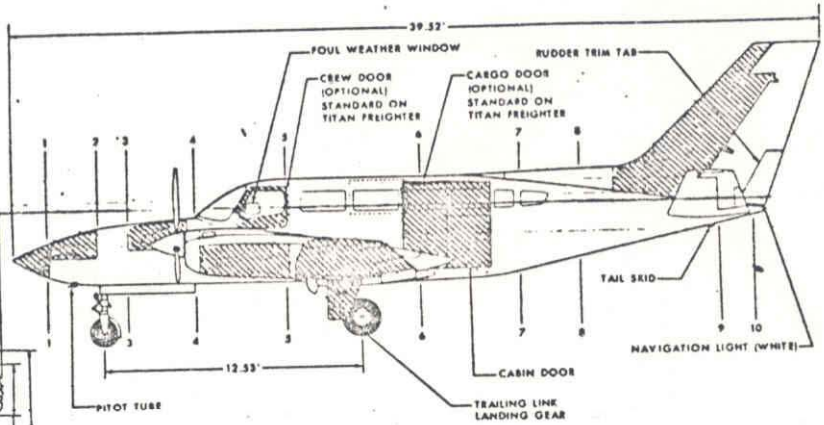
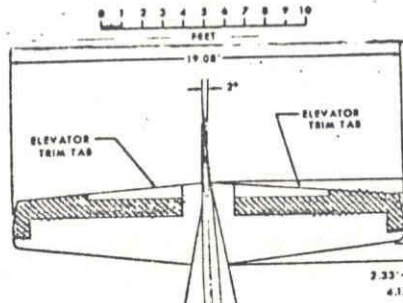
**TAIL - VERTICAL**  
ROOT: MACA 0012  
TIP: MACA 0009 MODIFIED

**TAIL - HORIZONTAL**  
ROOT: MACA 0012  
TIP: MACA 0010

**INCIDENCE**  
CENTER WING: +3°  
CONSTRUCTION TIP: -1°  
HORIZONTAL TAIL: 0°

**DIHEDRAL**  
CENTER WING: 3°30'  
OUTER WING: 4°55'  
HORIZONTAL TAIL: 12°

# TITAN AMBASSADOR TITAN COURIER TITAN FREIGHTER





Cessna.  
MODEL 425

**AIRFOILS**

**WING**

MACCRAFT MACA 33018 MODIFIED  
 HACHELLE NACA 23015 MODIFIED  
 TIP NACA 23009 MODIFIED

**TAIL - VERTICAL**

ROOT (LESS DORSAL)  
 NACA 0012 MODIFIED  
 TIP NACA 0009 MODIFIED

**TAIL - HORIZONTAL**

ROOT NACA 0012 MODIFIED  
 TIP NACA 0010 MODIFIED

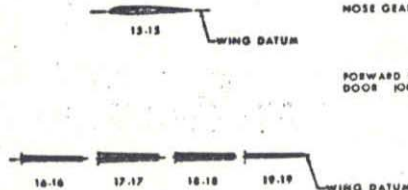
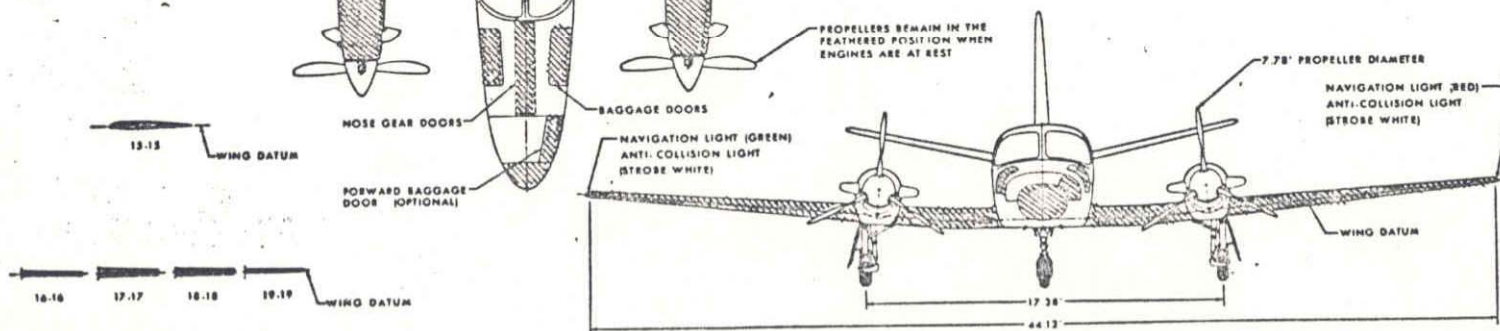
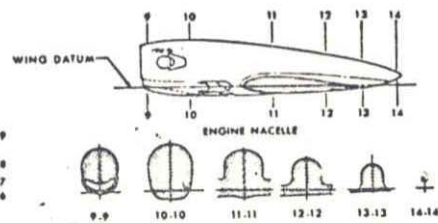
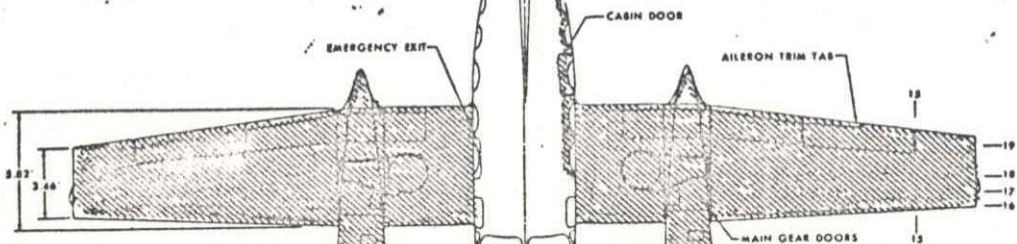
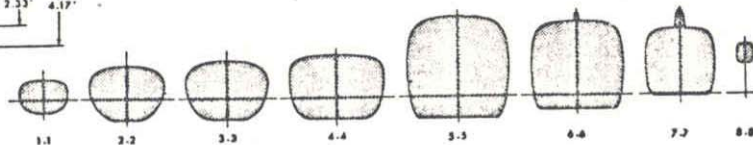
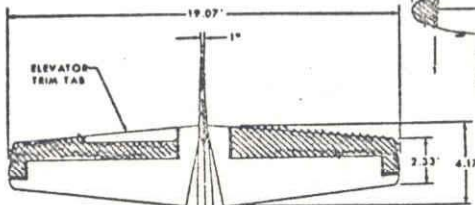
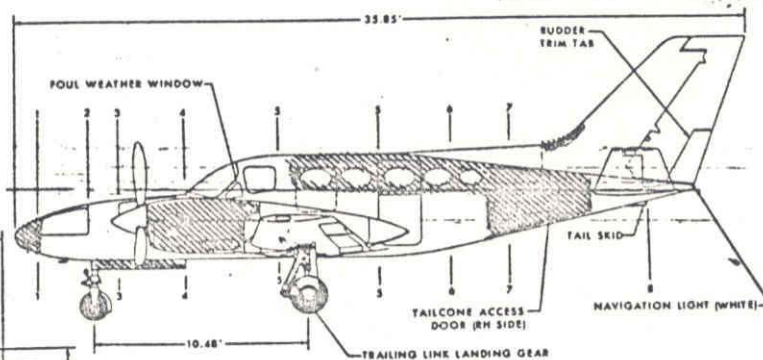
**INCIDENCE**

WING ROOT -  $+2^{\circ} 30'$   
 WING TIP -  $0^{\circ} 30'$   
 STABILIZER -  $0^{\circ} 0'$

**DIBEDRAL**

WING  $3^{\circ}$   
 HORIZONTAL STABILIZER -  $12^{\circ}$

**CORSAIR**



Cessna

1978 MODEL 441

# CESSNA CONQUEST

## AIRFOILS

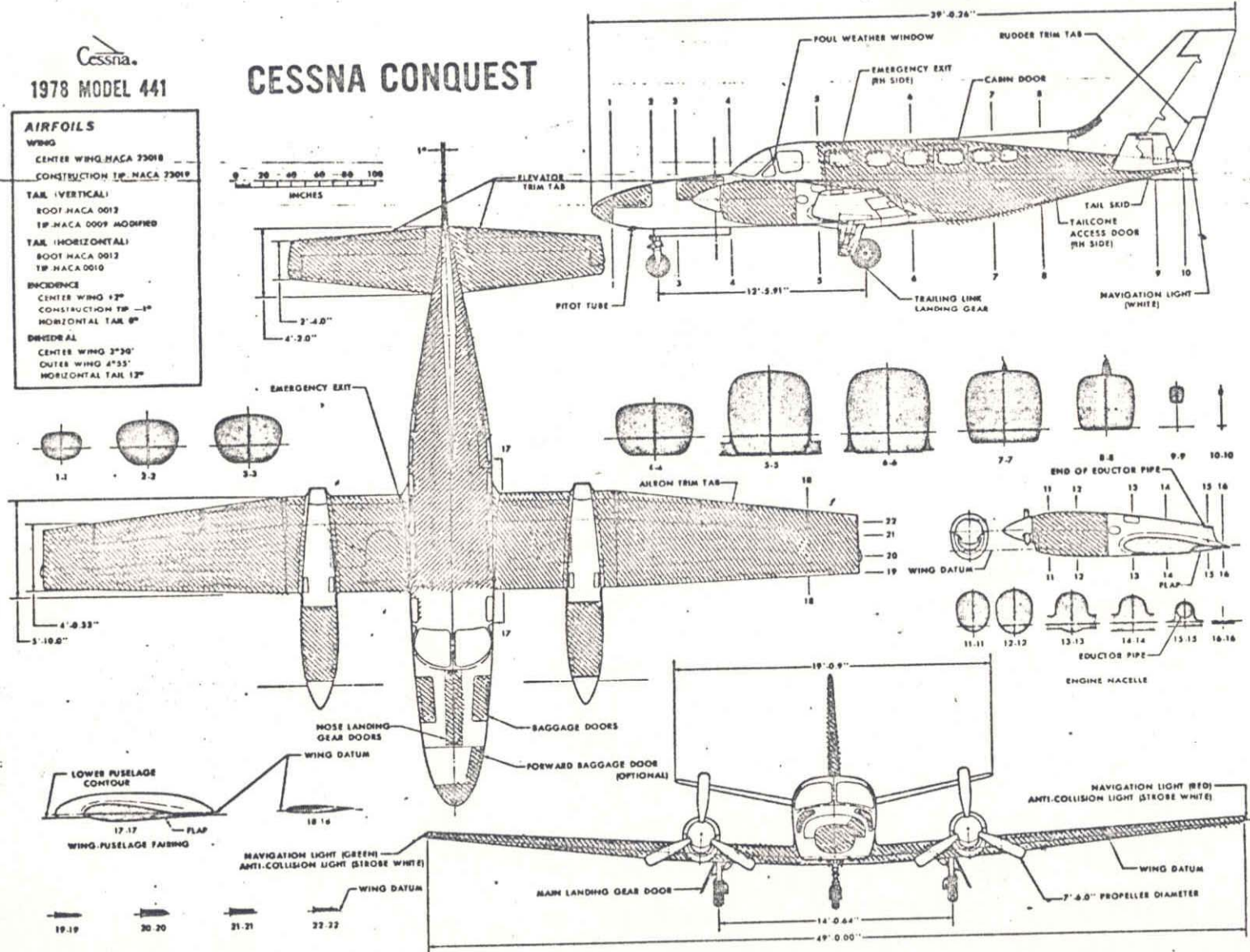
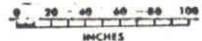
**WING**  
 CENTER WING HACA 33018  
 CONSTRUCTION TIP HACA 33019

**TAIL (VERTICAL)**  
 BOOT HACA 0013  
 TP HACA 0009 MODIFIED

**TAIL (HORIZONTAL)**  
 BOOT HACA 0013  
 TP HACA 0010

**INCIDENCE**  
 CENTER WING 12°  
 CONSTRUCTION TIP 1°  
 HORIZONTAL TAIL 0°

**DIGITAL**  
 CENTER WING 2°30'  
 OUTER WING 4°55'  
 HORIZONTAL TAIL 13°



## **Early Model 500 Citation Aircraft**

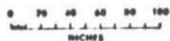
~ 1970 to mid 1980's

- **Clad alloys**
- **Acid etch surface treatment**
- **Chromate bond primer**
- **Paste and film adhesives**
- **Primarily autoclave cure**

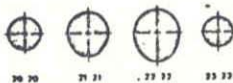
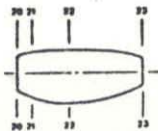
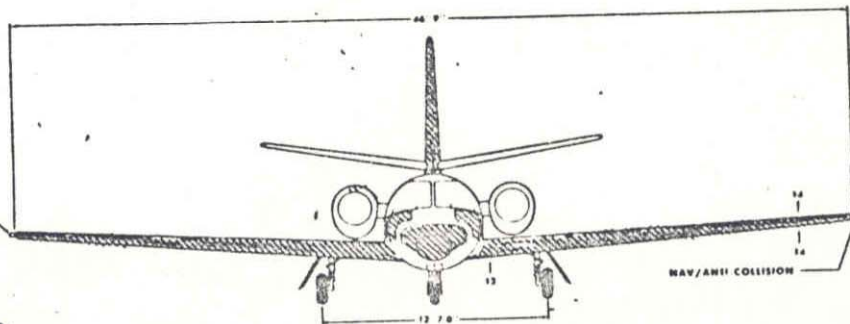
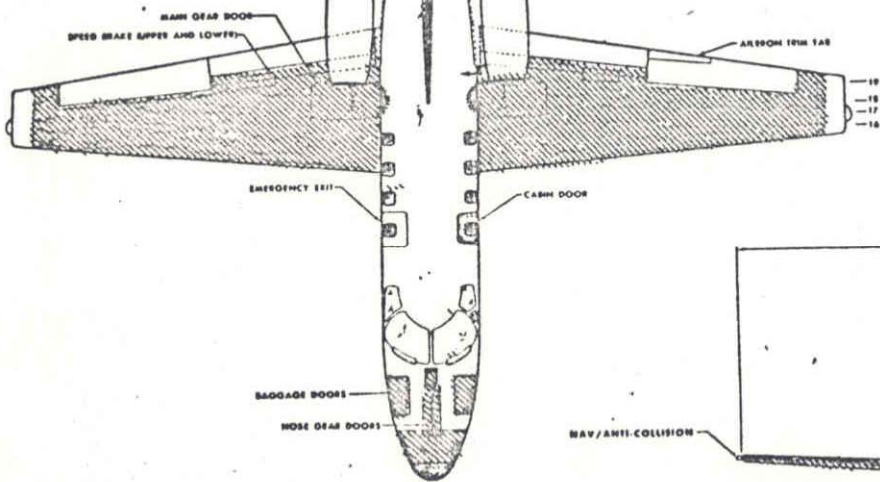
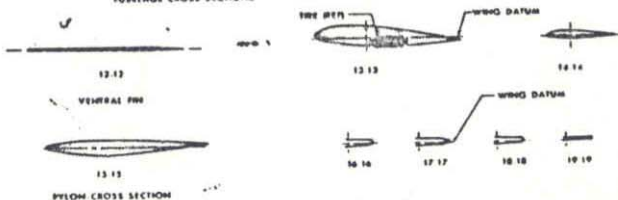
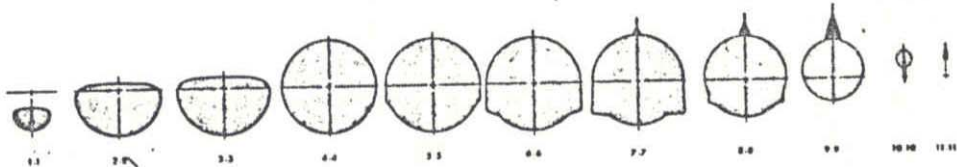
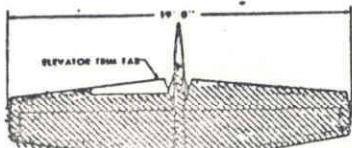
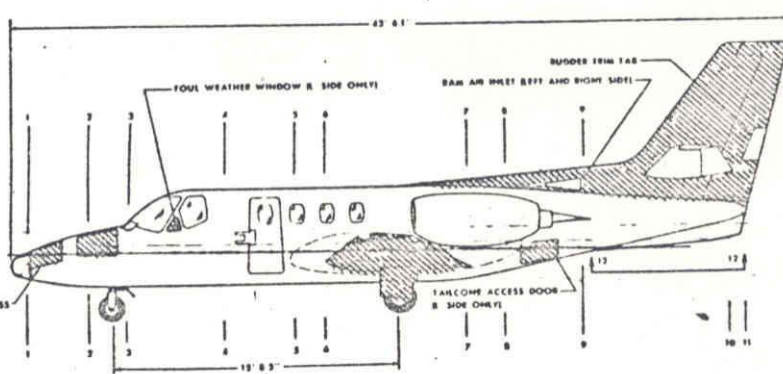
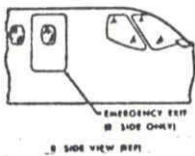


**CESNA CITATION I**  
**CESNA CITATION I, SP**

MODEL 500 & 501  
 UNIT 0425 & ON



AIRFOILS	
WING	<ul style="list-style-type: none"> <li>WING AIRPLANE: NACA 23014 MODIFIED</li> <li>W/S: 247.93 NACA 23017</li> </ul>
TAIL (VERTICAL)	<ul style="list-style-type: none"> <li>ROOT: NACA 0012</li> <li>TIP: NACA 0008</li> </ul>
TAIL (HORIZONTAL)	<ul style="list-style-type: none"> <li>ROOT: NACA 0018</li> <li>TIP: NACA 0008</li> </ul>
ENGINE	<ul style="list-style-type: none"> <li>WING: AIRPLANE +2° 30'</li> <li>WING W/S: 247.93 -0° 30'</li> <li>HORIZONTAL TAIL: -0° 7'</li> </ul>
ENGINE	<ul style="list-style-type: none"> <li>WING: 8°</li> <li>HORIZONTAL TAIL: 9°</li> <li>ENGINE PYLONS: 3°</li> </ul>



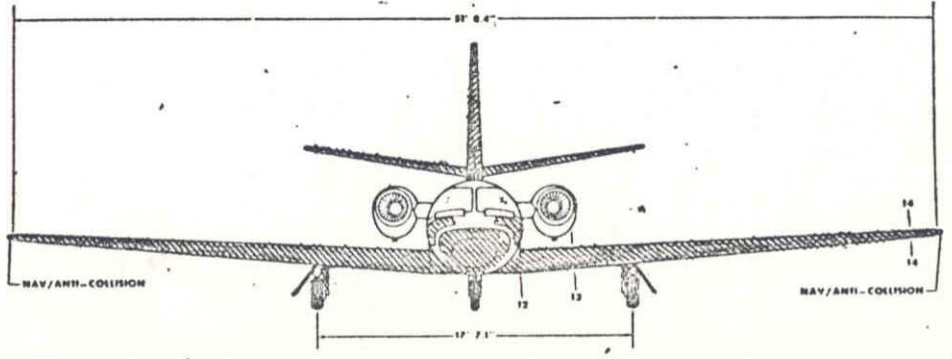
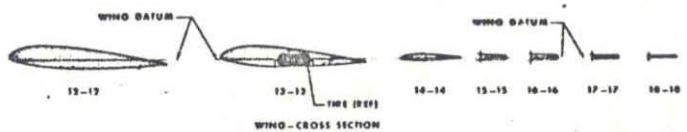
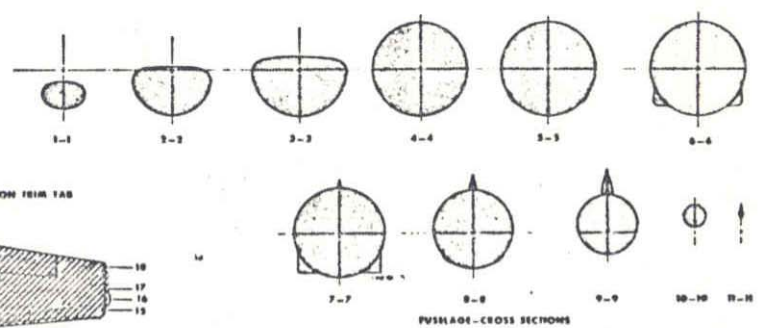
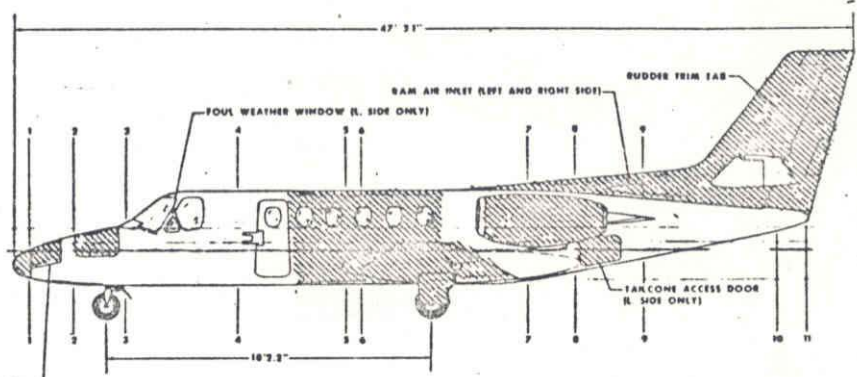
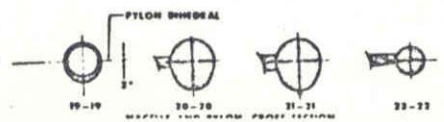
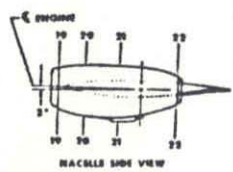
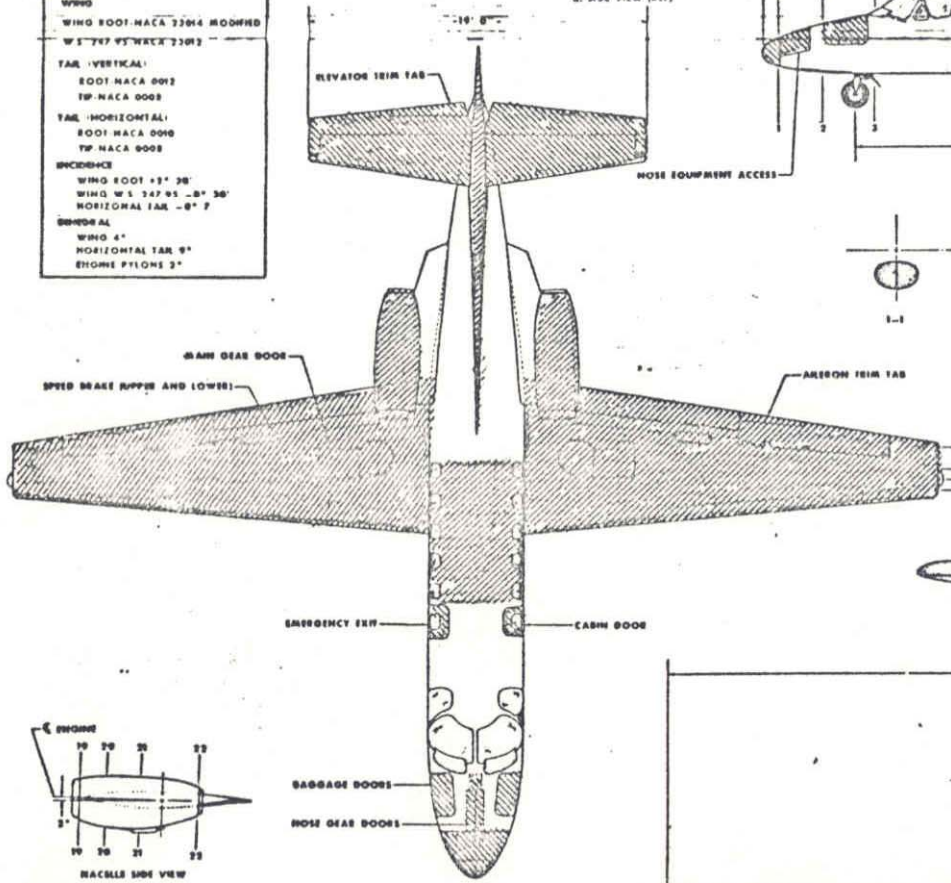
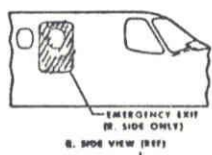
**CESSNA CITATION II**

**CESSNA CITATION II / SP**

MODEL 550 & 551  
UNIT 0001 & ON

**AIRFOILS**

- WING**  
WING ROOT: NACA 23014 MODIFIED  
W/S: 747.95' W/ACC: 22012
- TAIL (VERTICAL)**  
ROOT: NACA 0012  
TP: NACA 0008
- TAIL (HORIZONTAL)**  
ROOT: NACA 0010  
TP: NACA 0008
- INCIDENCE**  
WING ROOT: 13° 28'  
WING W/S: 147.95' - 8° 36'  
HORIZONTAL TAIL: -8° 7'
- DIHEDRAL**  
WING: 4°  
HORIZONTAL TAIL: 9°  
ENGINE PYLONS: 3°



# Current Generation Citation Aircraft

~ 1980 to Present

- **Bare alloys**
- **Phosphoric acid anodize surface treatment**
- **Chromate bond primer**
- **Primarily film adhesive**
- **Primarily autoclave cure**

CITATION III  
ADHESIVE BONDED STRUCTURE



■ KEVLAR-HONEYCOMB SANDWICH

■ GRAPHITE-HONEYCOMB SANDWICH

■ ADHESIVE BONDED SKINS, DOUBLERS, STRINGERS,  
RIBS, AND FRAMES

■ ADHESIVE BONDED SKINS AND DOUBLERS

■ FIBERGLASS

■ ALUMINUM SKIN-HONEYCOMB CORE

■ KEVLAR



## Why ?

**“Adhesive bonding was used to increase the efficiency of the structure with regards to strength, durability, and damage tolerance. The airframe is more weight efficient and has smoother exterior surfaces. The overall benefit is improved performance and lower life cycle costs.”**

Citation III Bonded Structure  
AIAA -84-2244  
July 10-12, 1984  
Hampton, VA