CESSNA SINGLE ENGINE SAFETY INITIATIVE

EASA "CESSNA SID – OPEN SESSION"

MARCH 13, 2014

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Cessna Single Engine Airplanes

- 145,000 produced between 1946-1986
- Average age is 43 years old
- Certified CAR 3
- Made of Aluminum
- Flown 100-150 hours annually

Cessna Single Engine Airplanes

/ IT IN **TRADE-A-PLANE**

/CS
$91
912

200

1977 C-177B, 2406 TTSN, 360 SMOH, 15 STOH. Approach approved GPS, HSI, moving map, King Silver Crown. New in 1992: Imron paint, all new windows. New in 1996: Custom Panel & avionics, leather interior, engine. $94,900.

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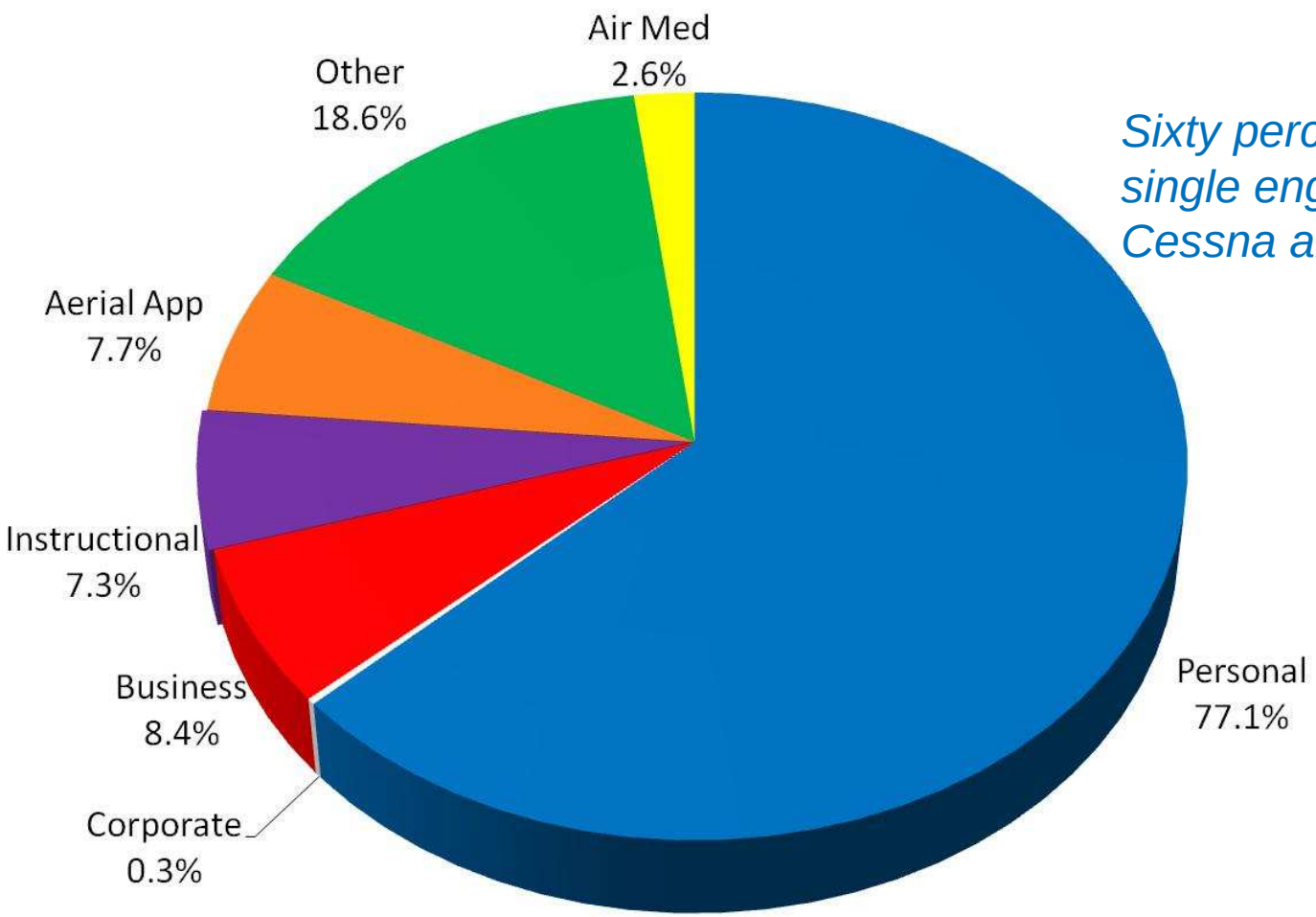
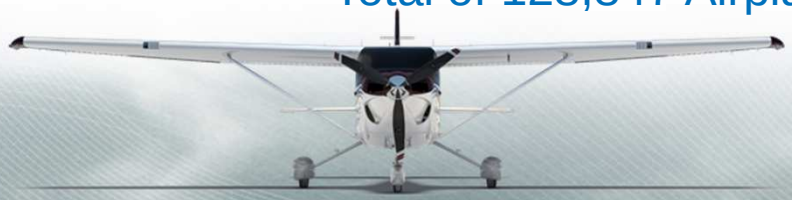
General Aviation



Sixty percent of active single engines are Cessna airplanes

2012 Single Engine Usage - Active US Aircraft
Total of 128,847 Airplanes Representing All Manufacturers



Source: FAA General Aviation and Part 135 Activity Surveys - CY 2012

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Past Safety Initiatives

- Continued Airworthiness Program (CAP)
  - Published in 1995 based on General Aviation Manufacturers Association (GAMA) Specification #7 - Continued Airworthiness Program (CAP)
  - Purpose is to provide comprehensive safety information to supplement airplane maintenance manual
  - Inspections include those items whose failure could cause loss or substantial damage to the airplane including
    - Structures
    - Systems including powerplant and electrical
- Structural CAP inspections have been replaced with the Supplemental Inspection Document (SID)
  - SEL-05-01 defines which CAP inspections have been replaced by the SID
  - System inspections defined in CAP are still required

Single Engine Safety Initiative

- Cessna has developed a new structural inspection program to assure the continued safe operation of single engine airplanes
- Visual inspection techniques are utilized to detect
  - Corrosion
  - Cracks caused by metal fatigue

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Single Engine Safety Initiative

- Why Inspect?
  - Corrosion (rust) and metal fatigue are inevitable

  - Corrosion and metal fatigue reduce the load carrying capability of the airframe
  - Like people, airplanes age, and more frequent and intrusive inspections are required to maintain health (safety)

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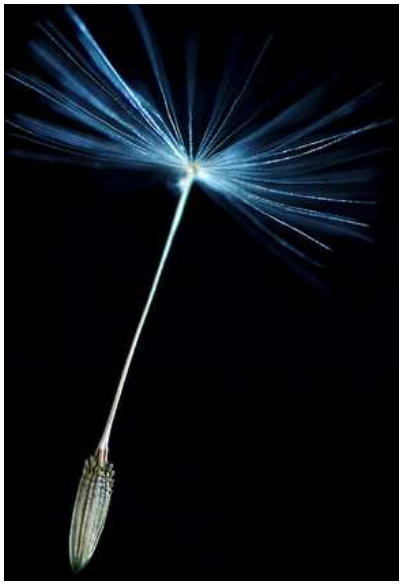
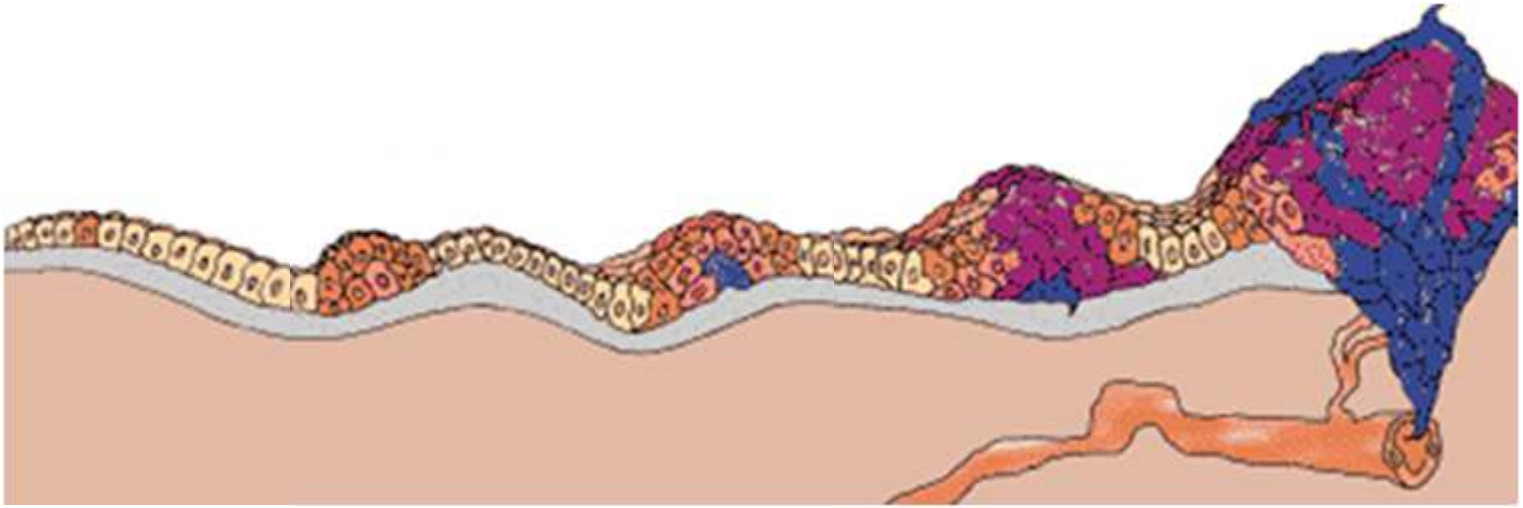
Visual Inspections



Undetectable → | Detectable → | Hazardous

Visual Inspections



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Visual Inspections

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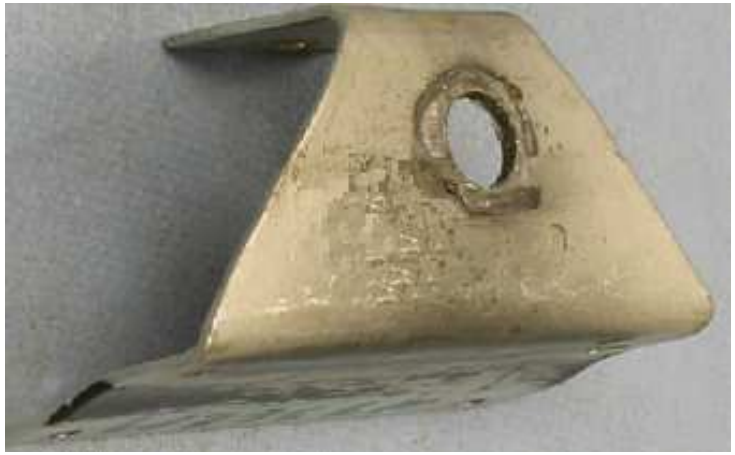
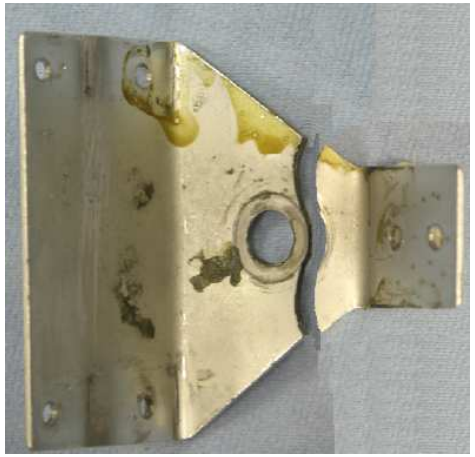
Visual Inspections





Undetectable → | Detectable → | → Hazardous

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Single Engine Safety Initiative

- Visual Inspections Work
  - Fifty percent of 300/400 series wing/fuselage attach fittings needed to be replaced

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What is Corrosion?

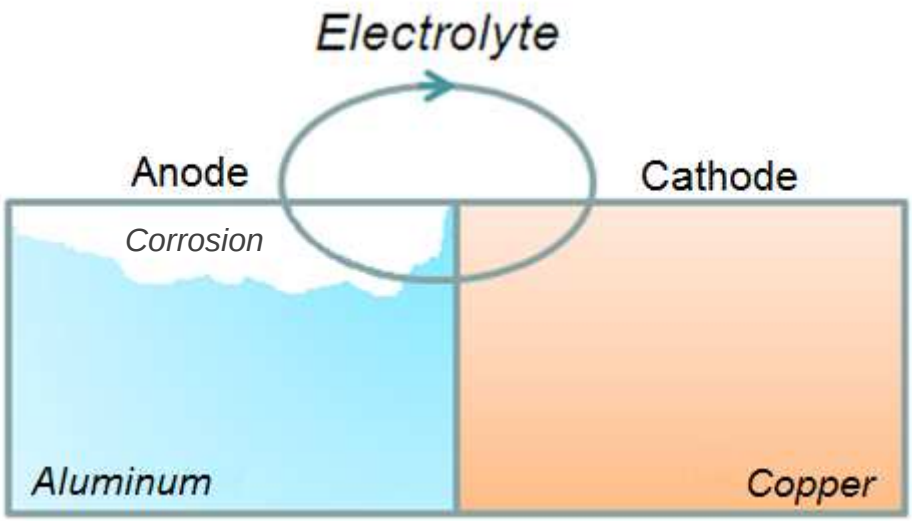
- Corrosion is the attack on metal by an electrochemical reaction to the surrounding environment
- Electrochemical corrosion can best be compared to a battery cell
  - In order for corrosion to occur, the following must be present:
    - A metal that gives up electrons (anode)
    - A metal that will accept electrons (cathode)
    - An electrical connection between the two metals (metal-to-metal contact)
    - A conductive liquid – typically water with some chemical impurity (salt, acid, chemical, etc.)

What is Corrosion?

- Pure aluminum is
  - Highly resistant to corrosion
  - Too soft to be used as a structural material
- Thus airframes are made of various high-strength aluminum alloys
  - The most common aluminum alloy used in airframes is “2024”
  - "2024“ is composed of 95% aluminum, 4% copper, and small amounts of manganese and molybdenum

What is Corrosion?

- 2024-T3 (aluminum sheet) has:
  - Excellent strength and toughness properties
  - Three of the four requirements for corrosion to occur
  - The only thing missing is the conductive liquid (electrolyte)



Corrosion Prevention

- Thus, the key to corrosion prevention is to keep the airframe free of moisture
- A major contributing factor to corrosion is the environment
  - Aircraft that operate in coastal environments are more susceptible to metal corrosion
    - While water vapor already has a corrosive effect, the water vapor and salt combination found in coastal environments creates a powerful corrosive agent
  - Aircraft that operate in areas that contain high amounts of industrial particles and fumes in the atmosphere also are more susceptible to corrosion
  - Aircraft that operate in areas where “environmentally friendly” runway deicers are used (i.e., potassium formate, potassium acetate, etc.) are more susceptible to corrosion

Corrosion Prevention

- There are several common options available to shield the aluminum from electrolytes including:
  - Cladding
  - Chemical Treatments
  - Sealants
  - Corrosion Prevention Compounds (CPCs)

Corrosion Prevention

- Cladding
  - 2024 sheet can be coated ("clad") with very thin layers (.001”) of pure aluminum to protect from corrosion
    - The resulting material is known as "2024-T3 Alclad"
  - The sheet material is vulnerable when the cladding is compromised
    - At edges, drilled rivet holes, or if it is scratched
    - Most airframe corrosion occurs at seams and joints, which is why cladding alone is not sufficient
    - Additional steps are necessary to protect seams, holes, and un-clad parts from exposure to electrolytes
- Chemical Treatments
  - Alodine or other chemical treatments are used to enhance the corrosion resistance of the pure aluminum cladding

Corrosion Prevention

- Sealants
  - Paint is the most commonly used sealant for corrosion protection
    - Modern polyurethane aircraft paints create a thick, impenetrable barrier that effectively keeps moisture away from the metal, and lasts a long time -- 10 years or more
    - A good paint job is the best defense against airframe corrosion
  - Paint only protects the exterior of the airframe
  - It is difficult to paint the inside of an airframe once it is all riveted together
  - The airframe interior of most pre-1986 airframes were not painted (primed)
- Corrosion Preventive Compounds (CPCs)
  - Effective means for protecting those parts of an airframe that were not originally protected from corrosion

Corrosion Prevention

- Corrosion Preventive Compounds (CPCs)
  - Guidelines for application and use of CPCs will be provided in the revised Service Manual
    - CPCs must be reapplied periodically
  - The following CPCs are approved for use on Cessna airplanes

Dry film compounds:	ARDROX AV-8* and AV-15 Cor-Ban 23* and Cor-Ban 35
Non-dry grease:	Cor-Ban 27L
Non-dry oil:	Corrosion X

* Preferred where high penetration of corrosion inhibiting compound is required.

Corrosion Prevention

- Continual inspections and preventative maintenance are required to keep the airframe metal from corroding
  - Thorough rinsing and cleaning of airplane will remove salt and other corrosive agents
    - Exposed areas such as the landing gear and wheel wells need extra attention, as well as any other joints, gaps, and hinges where debris collects
  - Chipped or delaminating paint needs to be properly striped or sanded and re-painted
  - During severe weather or wet conditions, airplanes should be covered and sheltered

Results of Corrosion

- Corrosion is responsible for approximately
  - 7% of the airworthiness directives [1]
  - 20% of service difficulty reports (SDRs)
- Corrosion can be deadly
  - Corrosion contributed to 91 accidents/incidents in the United States between 1983 and 1994 [2]
  - These and other accidents have resulted in hundreds of fatalities [3]
- As airplanes continue to age, these numbers are likely to increase

[1] Swift, S., "Rusty Diamond", 24th ICAF Symposium, May 2007.
[2] Hoeppner D,, Chandrasekaran V., Taylor A., "Review of Pitting Corrosion Fatigue Models", 20th ICAF Symposium, 1999.
[3] Aviation Safety Network Database, http://aviation-safety.net/index.php

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Corrosion and Metal Fatigue

- Corrosion and metal fatigue both reduce the load carrying capability of the airframe
- Corrosion and fatigue are not entirely independent processes - corrosion affects the expected fatigue life of airframe parts
  - Corrosion pitting creates a stress concentration which leads to crack initiation and potentially faster crack growth
  - Corrosion reduces the thickness of a part and therefore increases the stress in the part

Corrosion Examples

- Cabin Interior – All Models
- Models 177/210 Cantilever Carry-Thru
- Models 177/210 Cantilever Wing Attachments
- Model 200 Series Elevators
- Main Landing Gear – All Models
- Rudder Bar
- Strut Braced Wings
- Airframe Ribs – All Models

Cabin Interior – All Models

- Cabin is susceptible to corrosion given that it:
  - May leak when it rains
  - May be stored in un-insulated hangar or on the flight line
  - Stays warm as the airplane goes through thermal cycles during flight
    - Condensation will form on the interior skin
    - Moisture is absorbed by insulation and upholstery materials
  - Not often treated with corrosion prevention products
  - Headliner is not always removed during an annual

Cabin Interior – All Models

Corrosion

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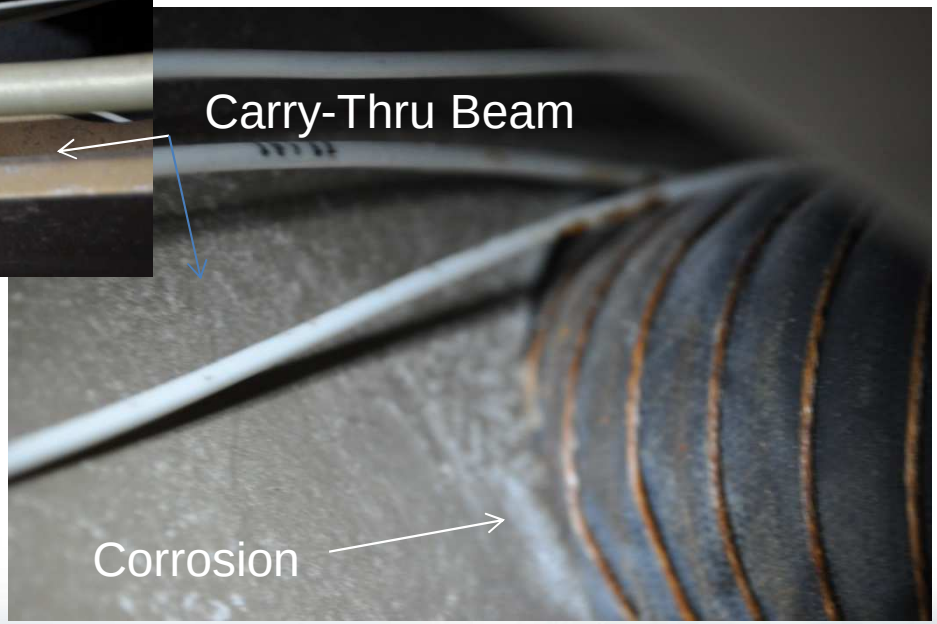
Models 177/210 Cantilever Carry-Thru

- Provides the primary means of carrying wing loads across the fuselage
- Made of 2014-T6 material
  - High strength material but is very susceptible to corrosion
- Corrosion occurs when
  - Ducting contacts lightening holes in beam, or
  - Moisture accumulates on I-beam surface
- Limited repairability

Models 177/210 Cantilever Carry-Thru



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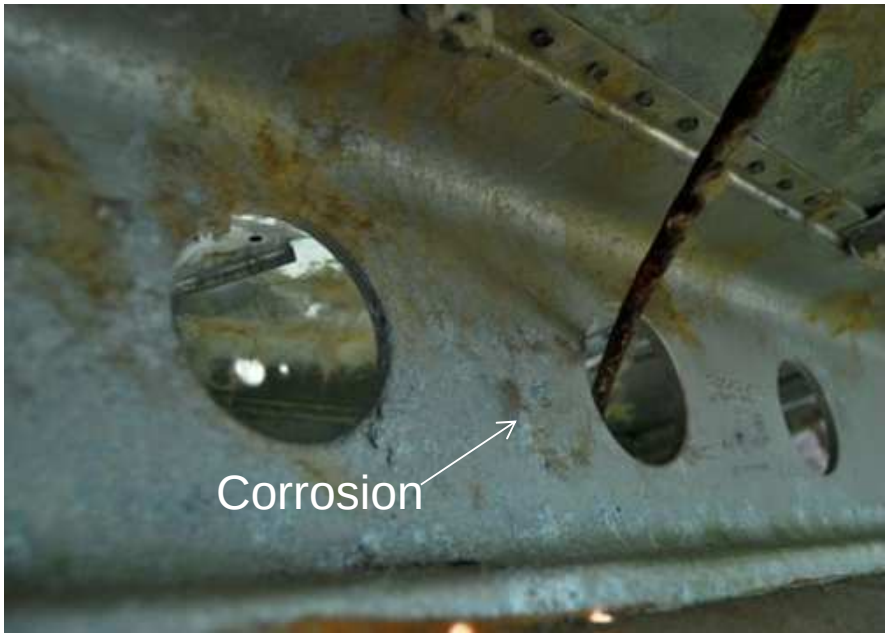
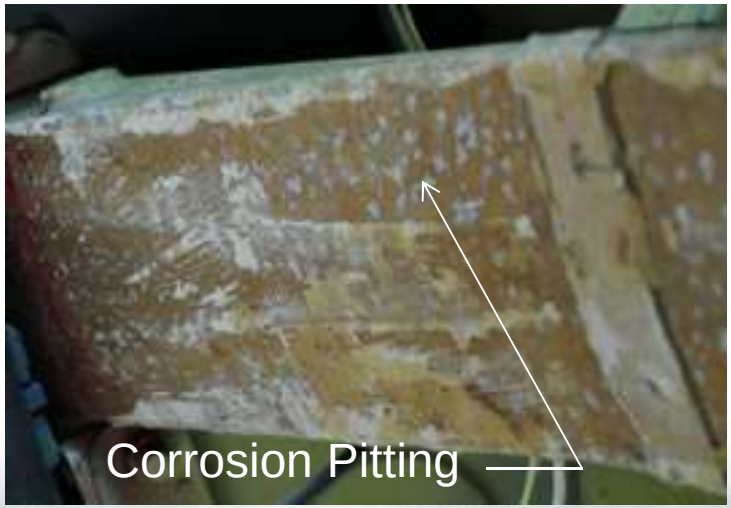
Models 177/210 Cantilever Carry-Thru





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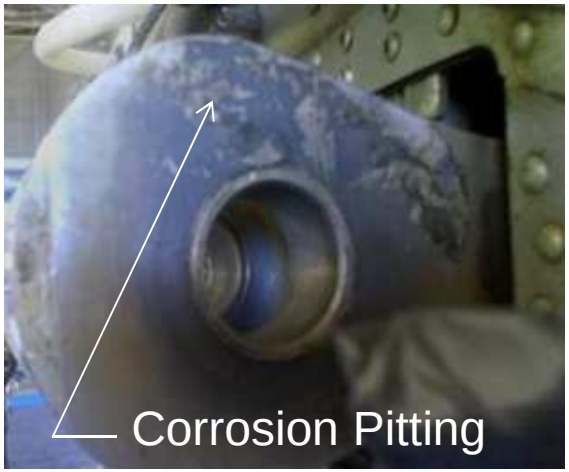
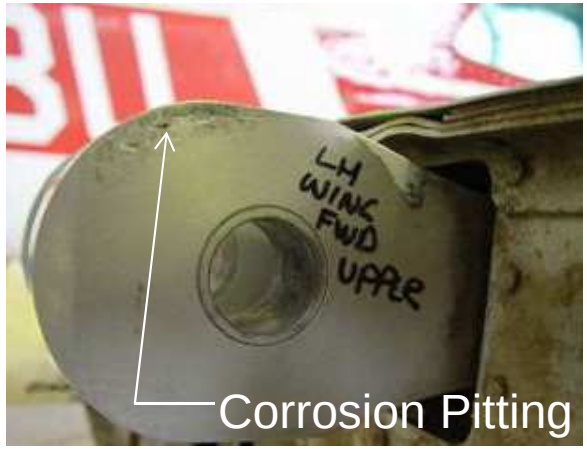
Models 177/210 Cantilever Wing Attach

- Primary load carrying member
- Corrosion is common on the carry-thru lugs and the wing attach fittings
  - Tight fitting faces act as a moisture trap
- Made of 2014-T6 material
  - High strength material but very susceptible to corrosion

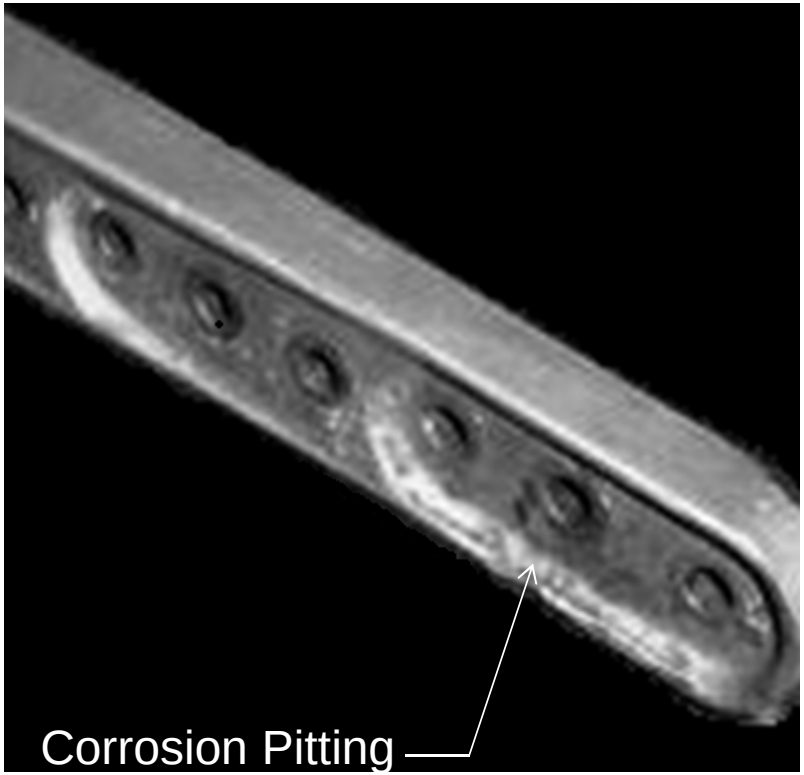
Models 177/210 Cantilever Wing Attach



Carry-Thru Spar Lug



Wing Attach Fitting

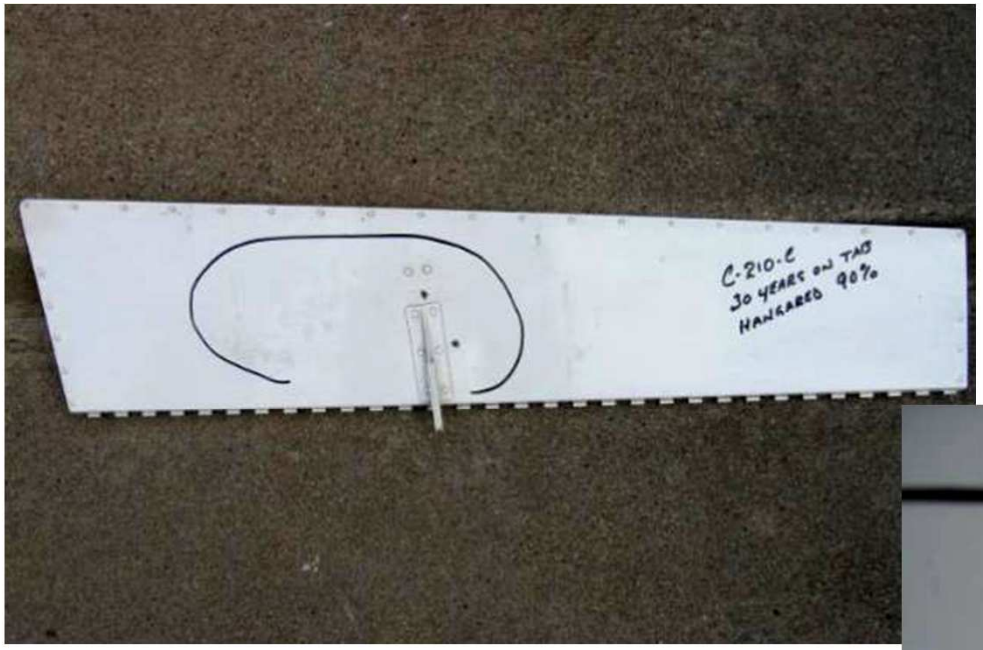


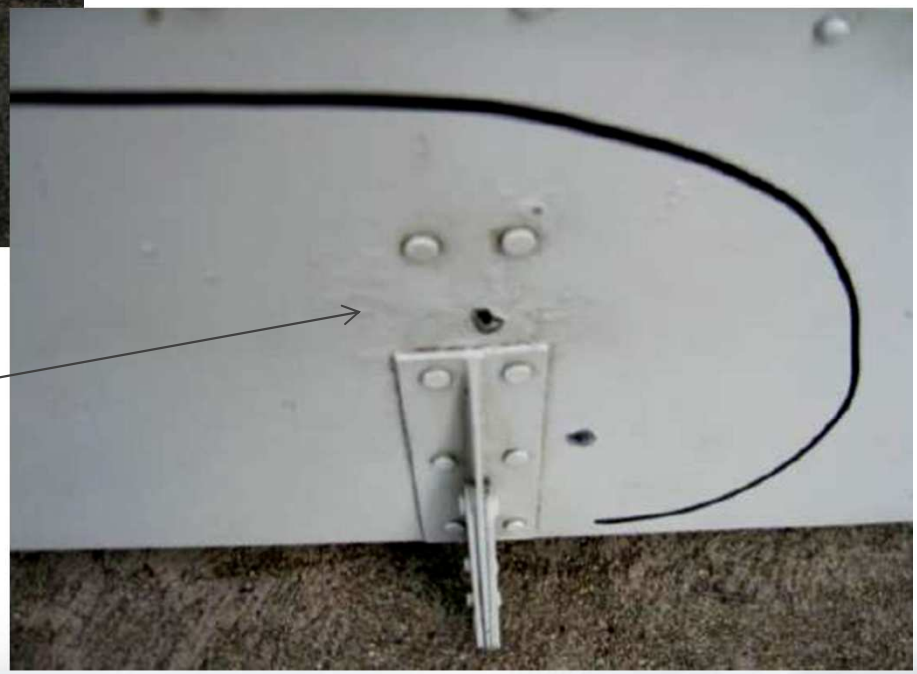
Wing Attach Fitting

Model 200 Series Elevators

- Foam filled trim tab and foam filled trailing edge
  - Absorbs moisture
    - Results in corrosion
    - Changes elevator balance
  - When trim tab skin thins due to corrosion, the actuator can pull the fasteners through skin and disconnect
  - Not repairable
  - Inspect for pinholes, surface roughness, bubbling
  - FAA SAIB CE-05-27R1 recommends replacement of tab and trailing edges with non foam filled parts

Model 200 Series Elevator Trim Tabs





Corrosion

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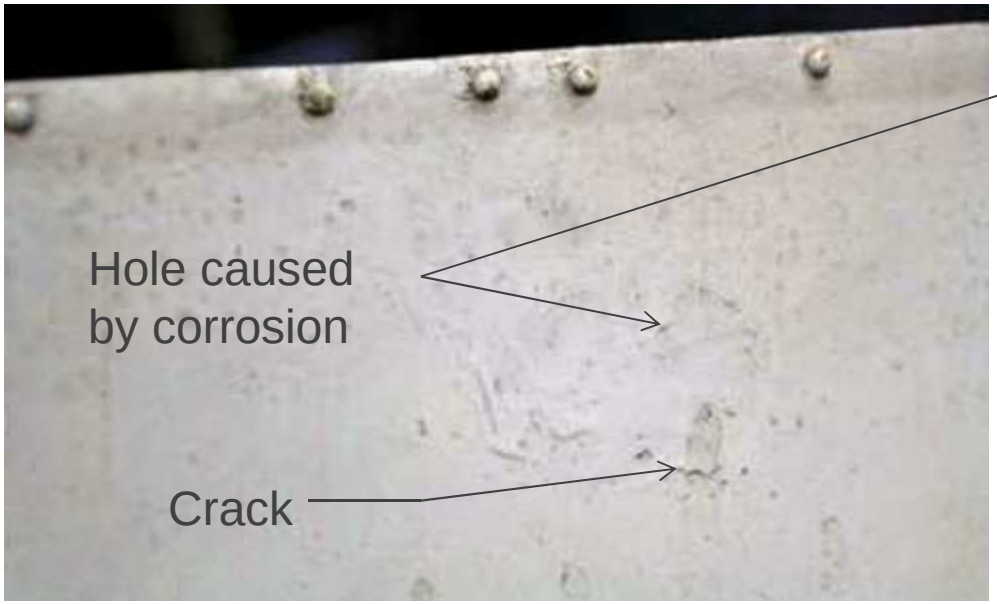
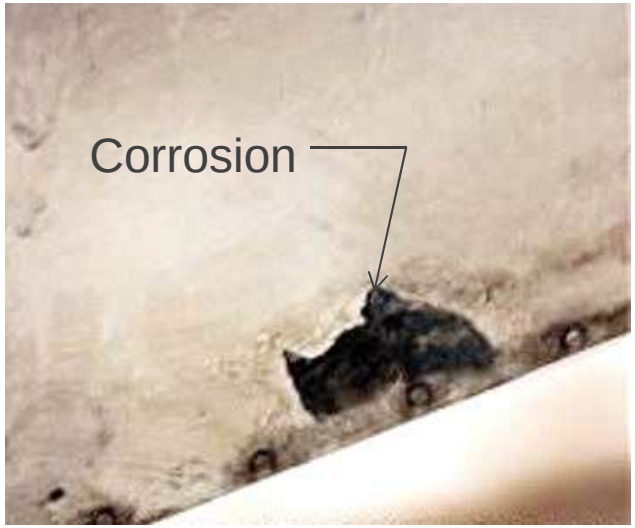
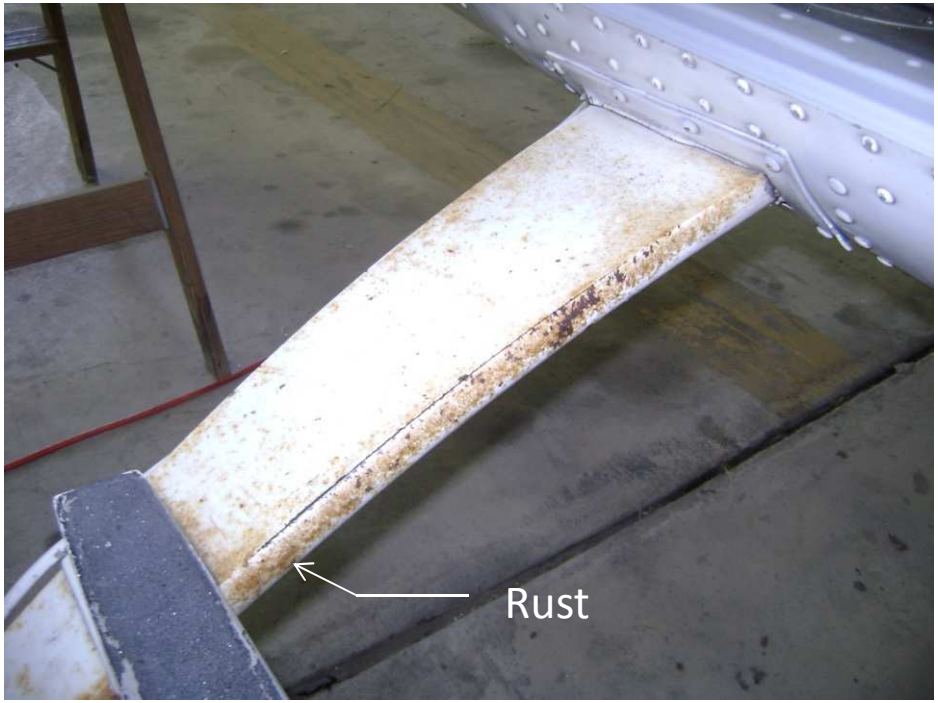
Model 200 Series Elevators





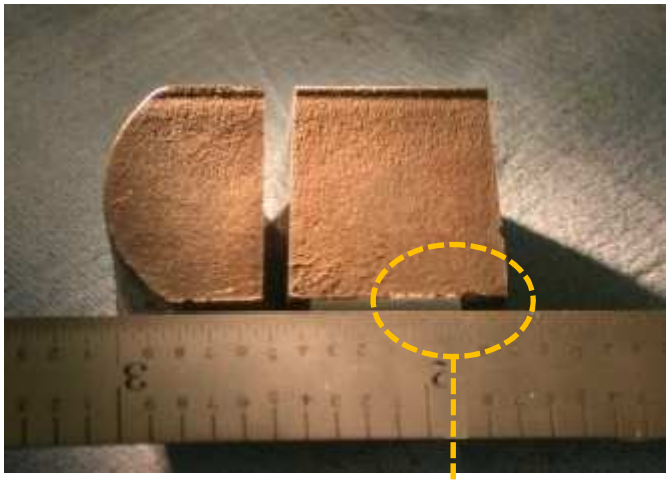
Main Landing Gear

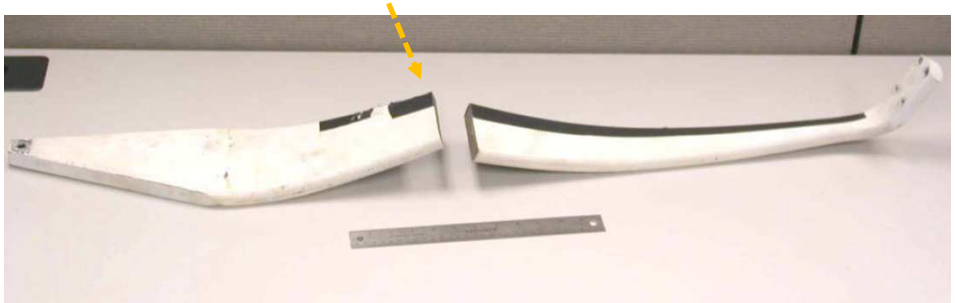
- Made from 6150M High-Strength Steel
- A pit as small as .005” can initiate a fatigue crack which will result in fracture of the gear
- Keep surface painted with polyurethane paint and blend out pits per Service Manual



Model 182 Flat Spring Gear

Main Landing Gear



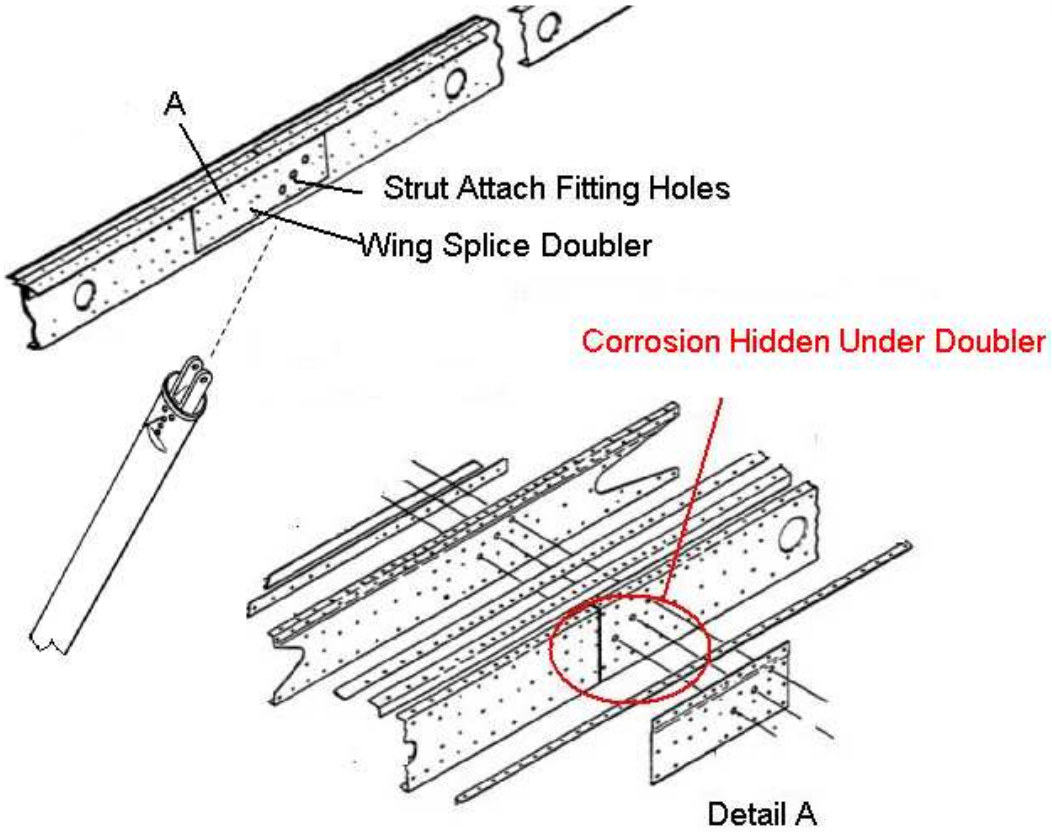


Rudder Bar

Fractured Pedal Arm Tube

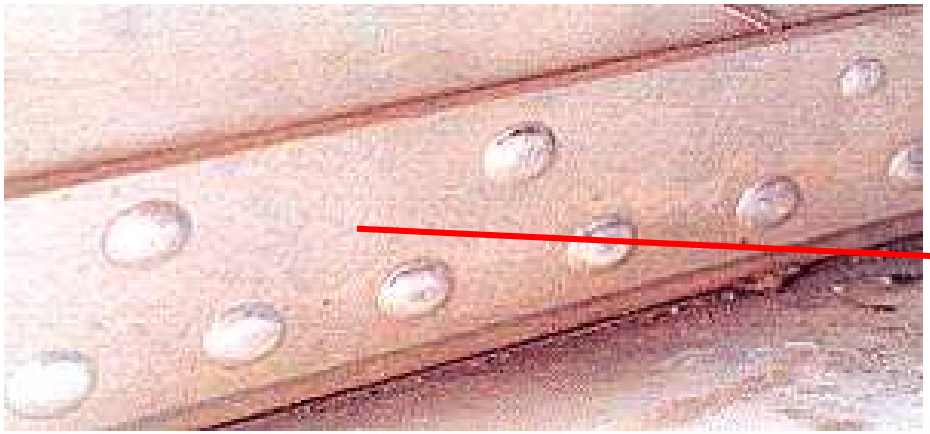
Strut Braced Wing Front Spar

- Wing spar made from several sheets of 2024-T3 aluminum clad riveted together
- Strut attaches at wing splice joint
- Corrosion observed in underlying sheets



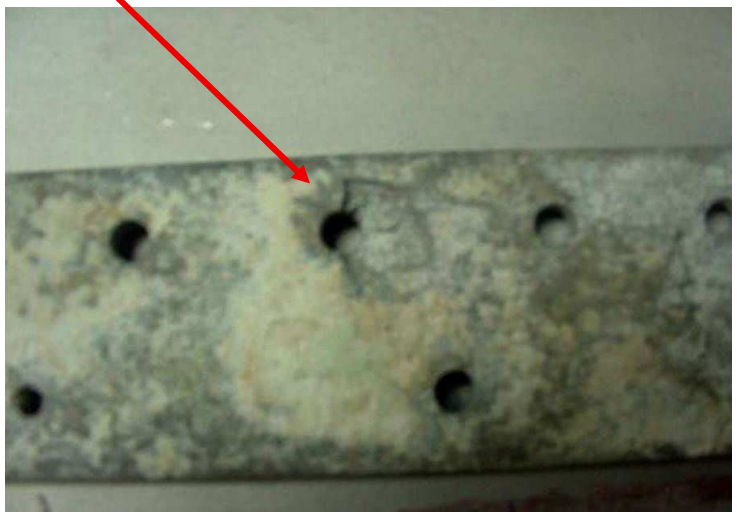
Strut Braced Wing Front Spar

- Corrosion is often indicated by the discovery of a missing rivet
  - If rivet is missing, corrosion is likely to be severe
- Australia asks owners to remove leading edge after 15 years, inspect and reassemble with primer



Strut Braced Wing Front Spar

Front Spar



Doubler

Source: CASA General Aviation Aircraft Corrosion

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Strut Braced Wing Front Spar

Spar Splice

Source: CASA General Aviation Aircraft Corrosion

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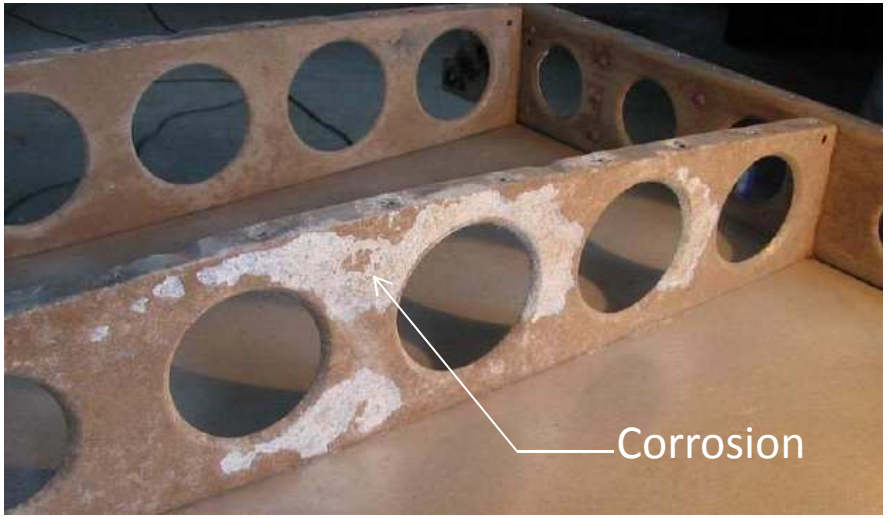
Strut Braced Wing Front Spar

Front Spar Fuselage Attachment

Airframe Ribs



"A repair station found severe corrosion in the front and rear wing to fuselage attachments. There was so much corrosion (many of the rivets had broken off the wing's rear attachment), and when the corrosion was removed many more rivets fell out. The vertical stabilizer was opened up and more significant corrosion was found."

Source: FAA Maintenance Alert 43-16A, May 2006

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Metal Fatigue

- Aviation has had to address metal fatigue in the design and inspection of airframes since 1954
- Fatigue can be deadly
  - Metal fatigue contributed to 2240 deaths in 1885 airplane accidents between 1927 and 1980[1]
    - The five most common fatigue crack initiation sources in these accidents were: (1) bolt, stud or screw; (2) fastener or other hole, (3) fillet, radius or sharp notch; (4) welds and (5) corrosion
  - Over 700 people have died in fatigue related accidents since 1980[2]

[1] Campbell and Lahey 1984, 'A Survey of Serious Aircraft Accidents Involving Fatigue Fracture', *International Journal of Fatigue,* January 1984

[2] 'Investigation into Ansett Australia Maintenance Safety Deficiencies and the Control of Continuing Airworthiness of Class A Aircraft', Appendix 8 from the Australian Transport Safety Bureau's web site, www.atsb.gov.au.

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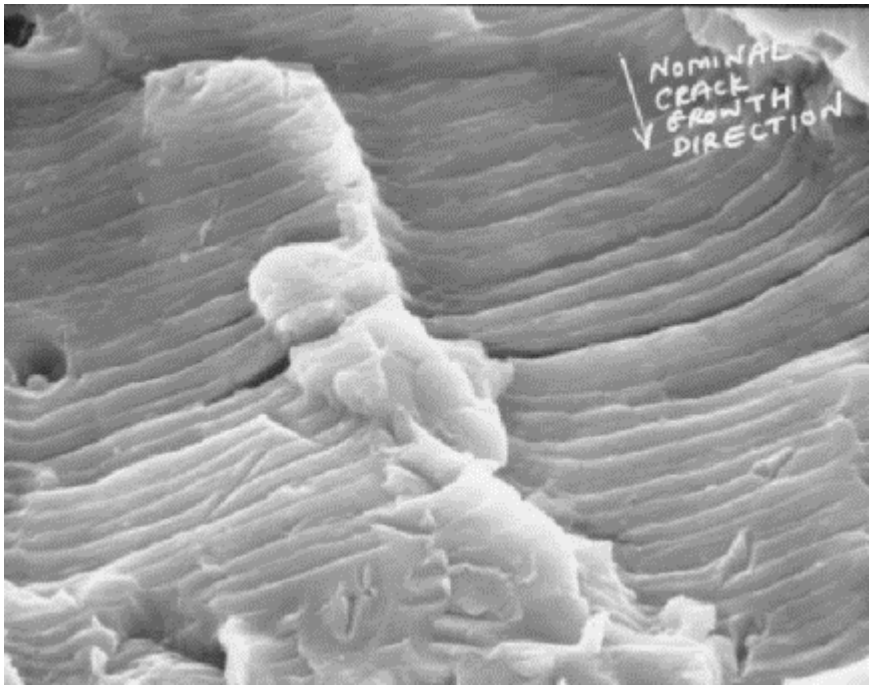
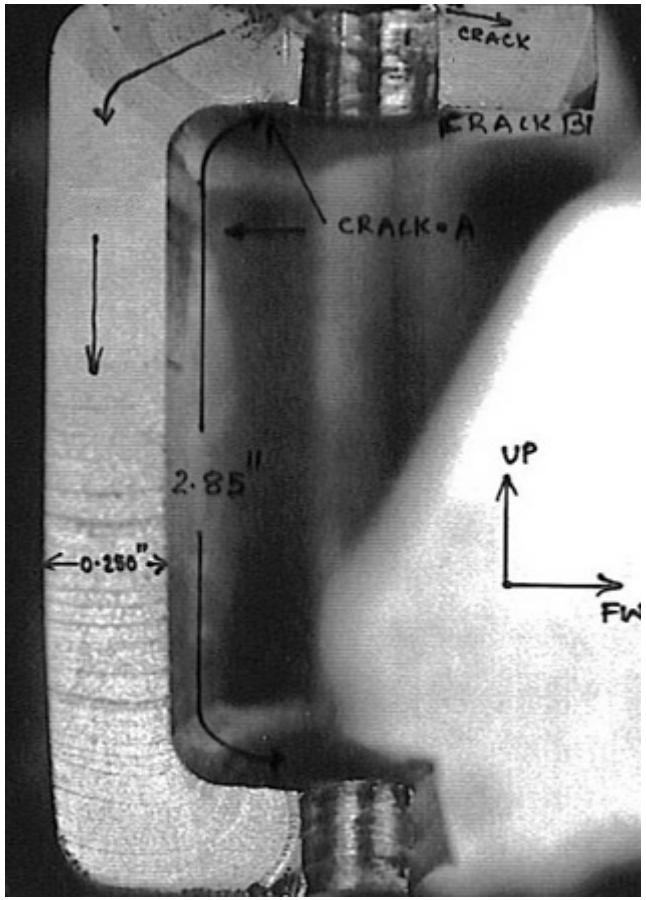
What is Metal Fatigue?



Fatigue Under Microscope

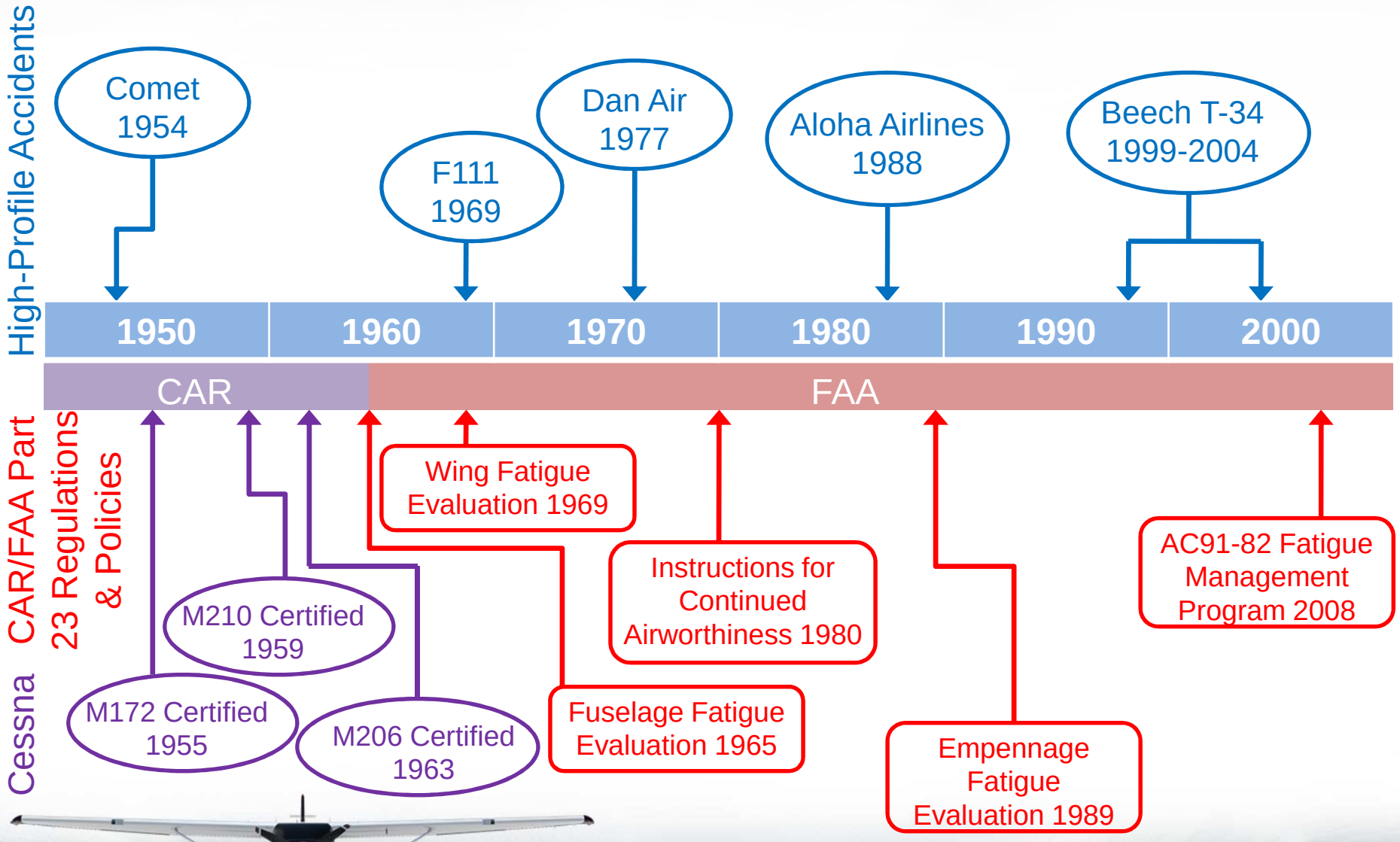


Typical Fatigue Failure

Metal Fatigue

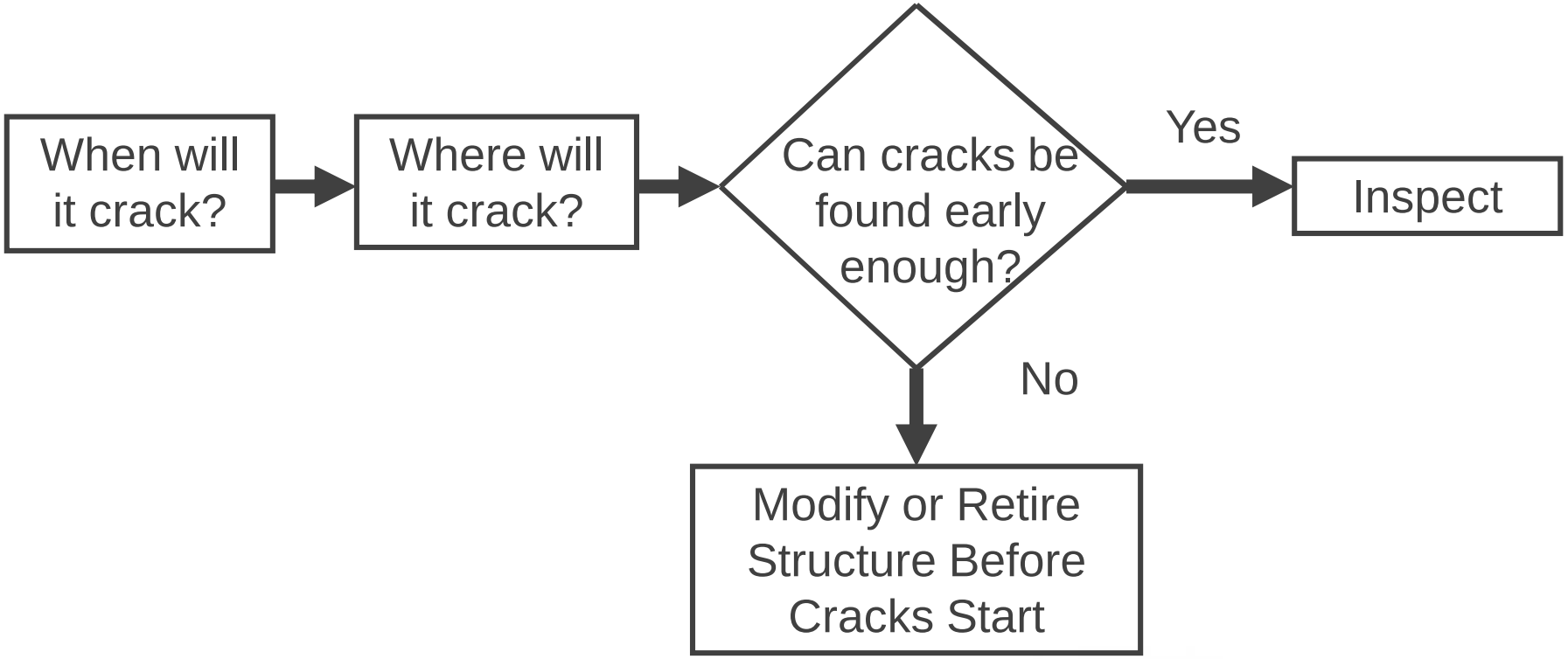
- Due to some high-profile accidents caused by metal fatigue FAA Regulations have changed through the years in order to improve safety. Each accident led to:
  - Changes in certification requirements
  - Changes in existing inspection programs

FAA Regulations Through the Years



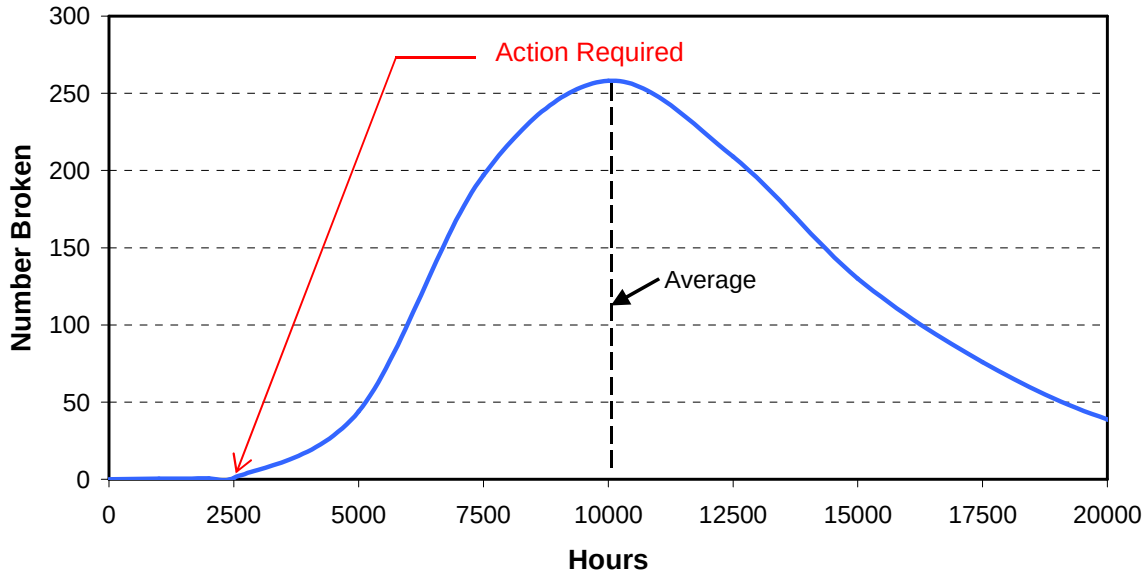
How to Control Metal Fatigue

- Primary questions to ask



How to Control Metal Fatigue

- When will it crack?
  - Suppose 1000 identical wing spars were fatigue tested with the same loads
  - Assume the average wing spar breaks at 10,000 hrs
  - They won't all break at the same time



How to Control Metal Fatigue

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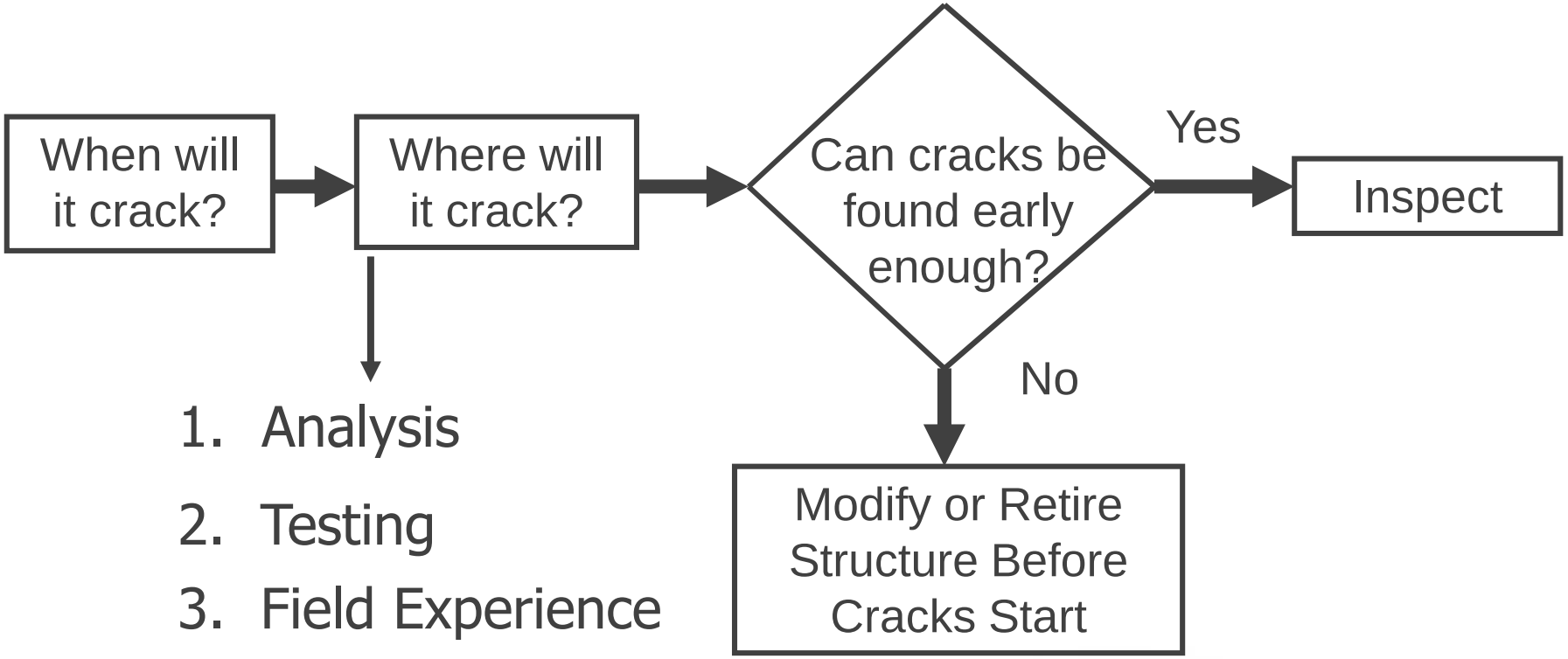
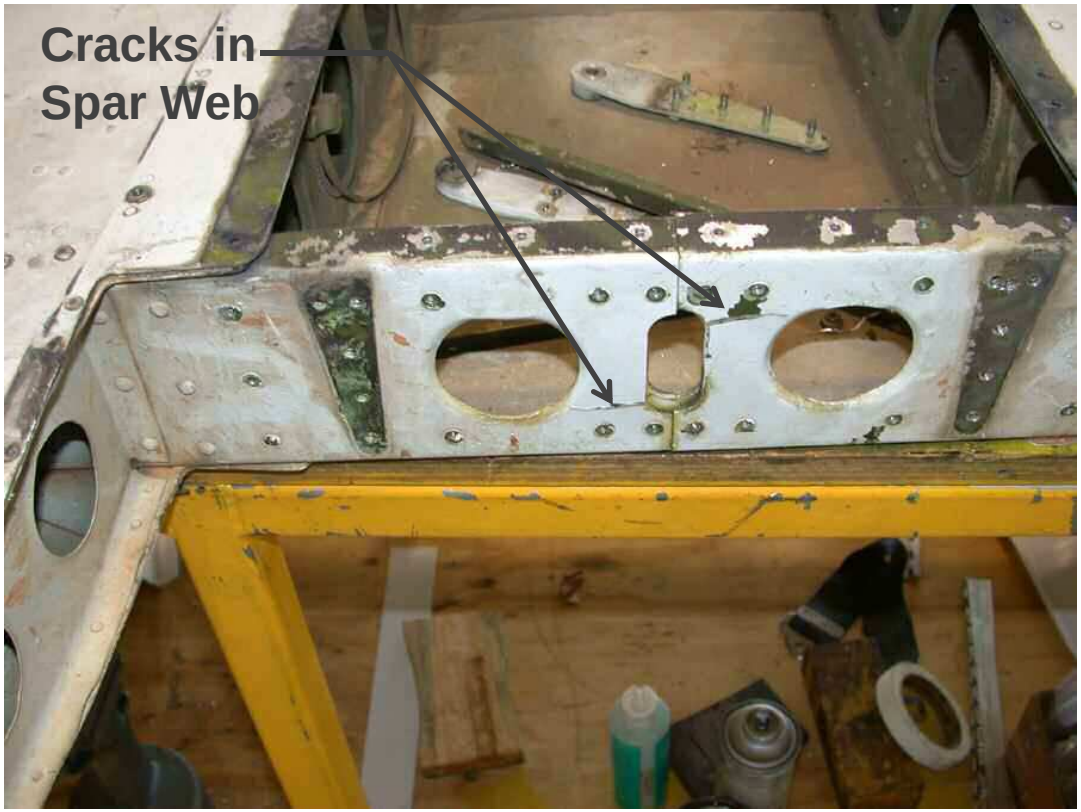


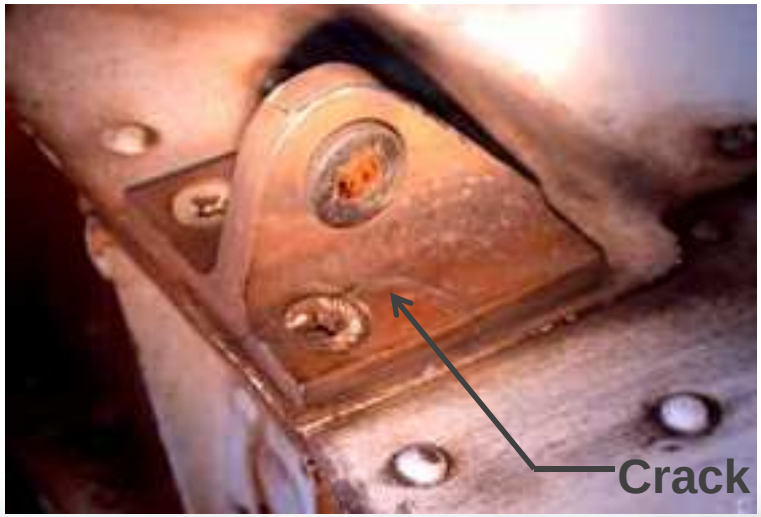
1. Analysis
2. Testing
3. Field Experience

Metal Fatigue Examples

- 200 Series Horizontal Stabilizer
- 200 Series Aft Bulkhead
- Model 172/175 Horizontal Stabilizer
- Model 150/152 Vertical Stabilizer Attach
- Model 185 Horizontal Stabilizer Reinforcements
- Model 210 Wing Spar
- Models 172/182/206/210 Forward Doorpost at Strut Attachment
- Engine Mount Truss
- Main Landing Gear Support
- Model 172RG Main Landing Gear Actuator

200 Series Horizontal Stabilizer Front Spar





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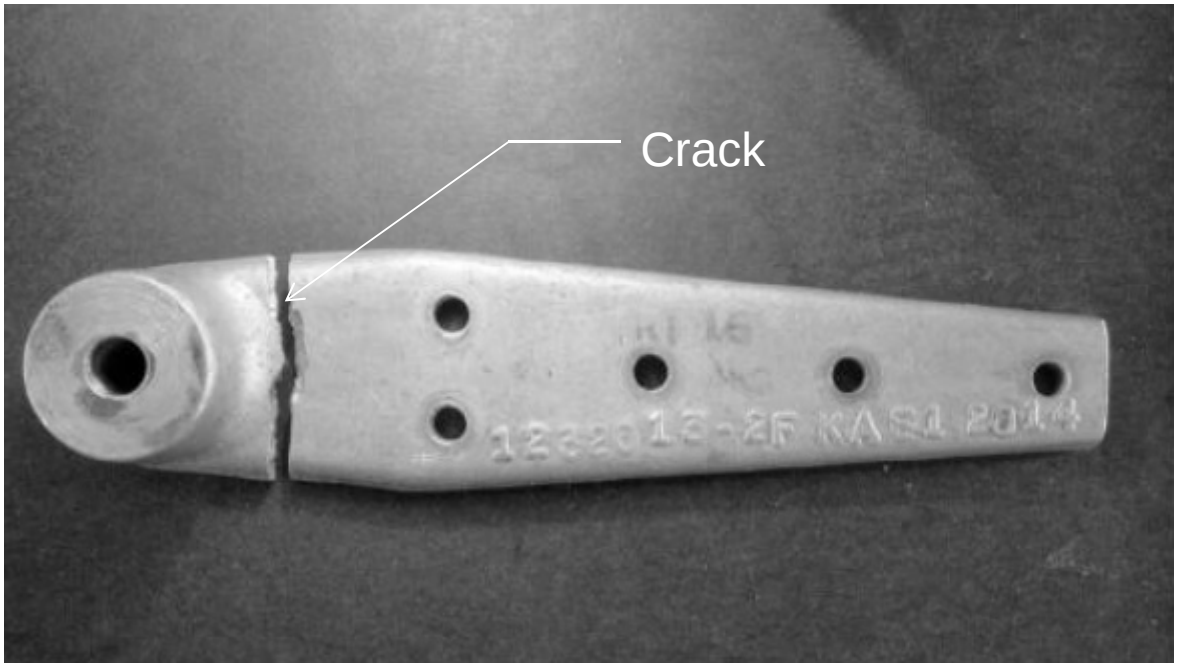
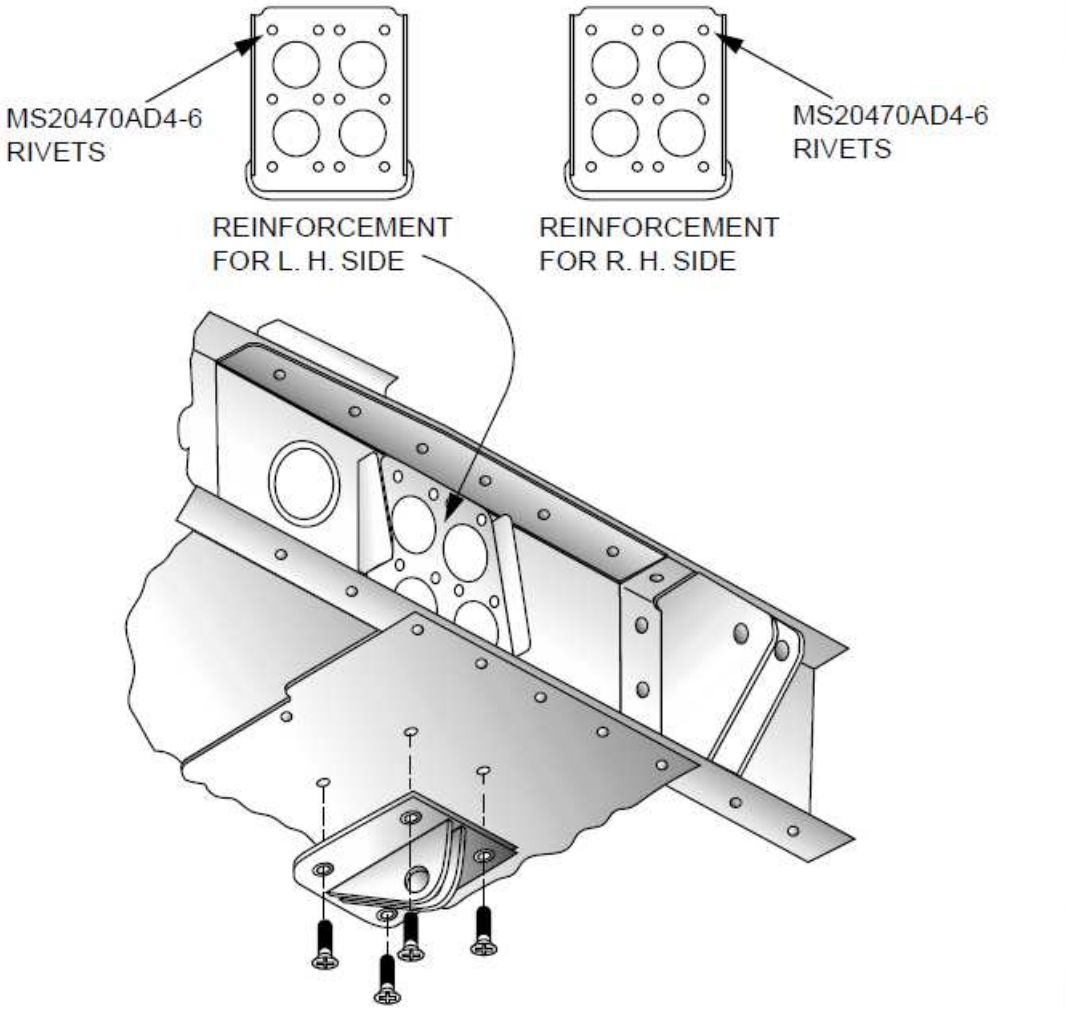
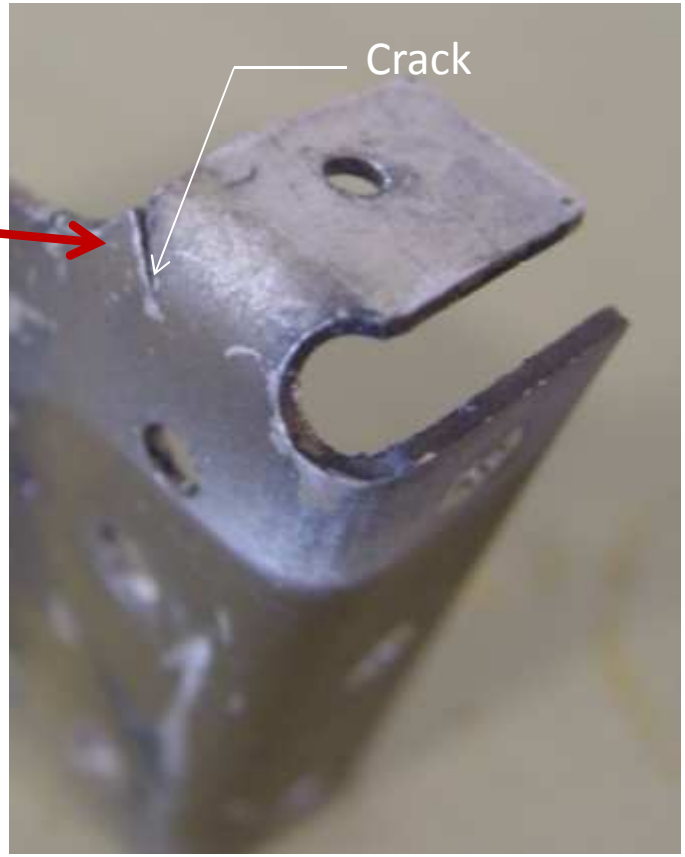
200 Series Horizontal Front Spar Attach



200 Series Horizontal Stabilizer Trim Actuator Brackets



200 Series Aft Bulkhead



Source: FAA Maintenance Alert 43-16A, May 2011

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Model 172/175 Horizontal Front Spar

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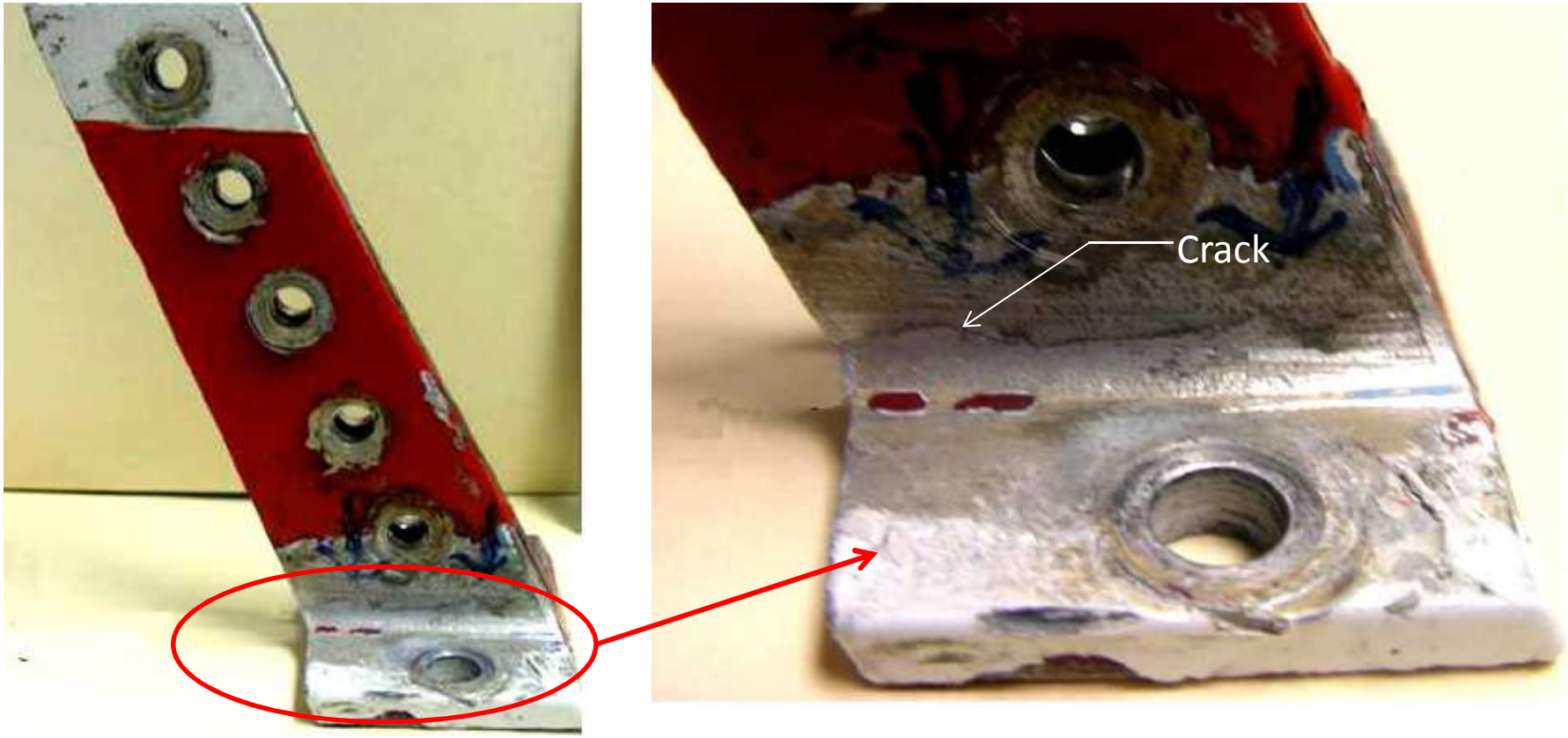
Model 150/152 Vertical Stabilizer Attach



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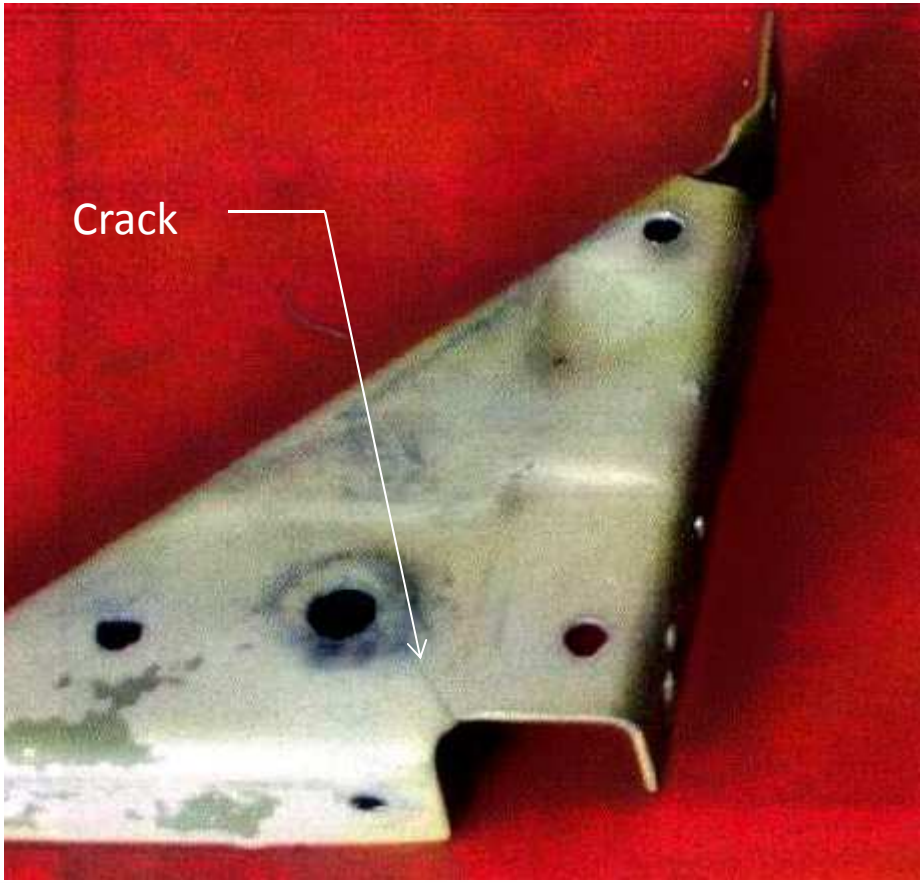
Model 185 Horiz. Stabilizer Reinforcements



Source: FAA Maintenance Alert 43-16A, July 2007

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Model 210 Main Spar Cracks

- Model 210 wing (1967 models and on) is an all metal wing panel
  - Full Cantilever
  - ***Single Main Spar***
- SEL57-01-1 Revision 3 issued to inspect for cracks both visually and with eddy current
- Model 177 has similar design to Model 210

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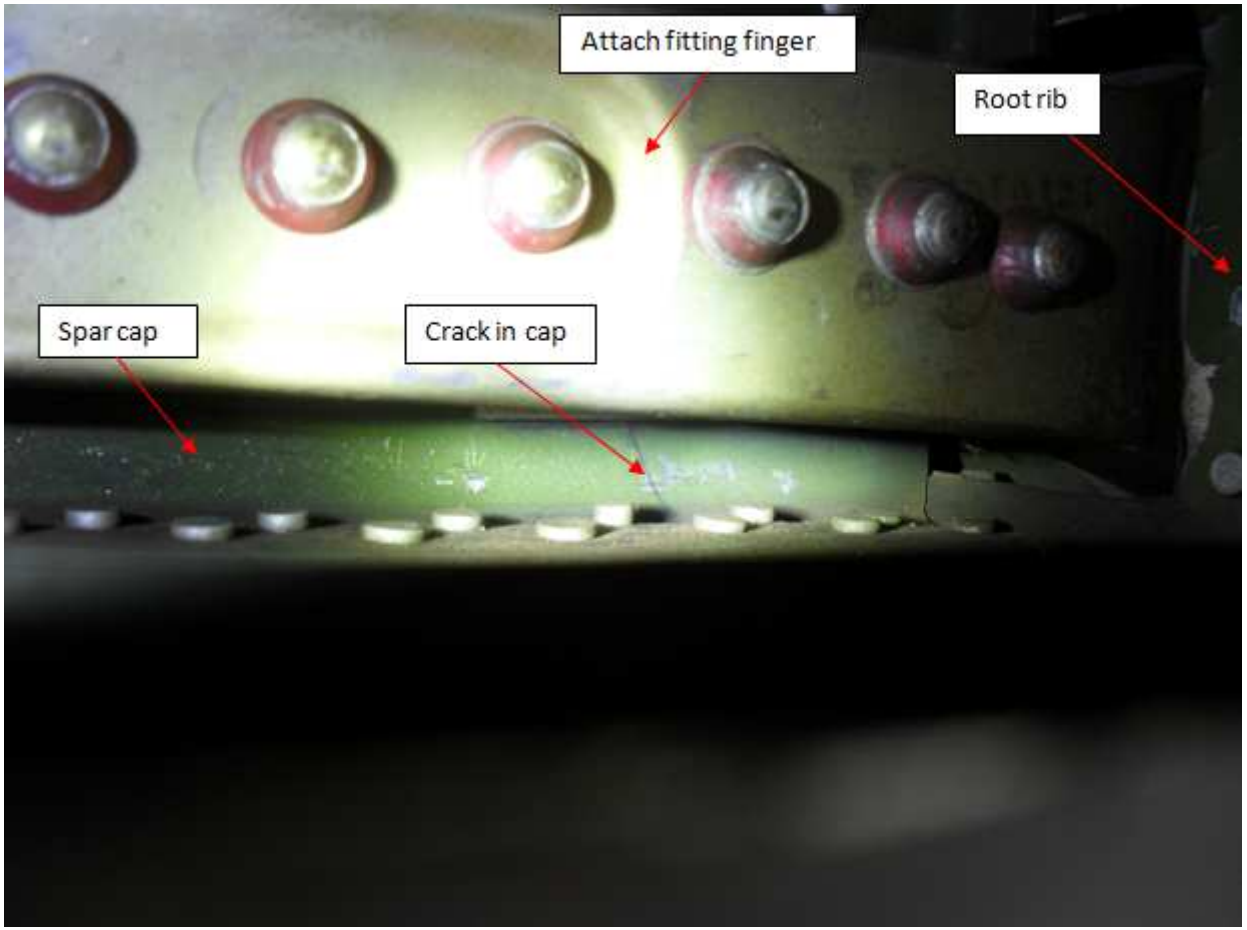
M210 Main Spar Cracks

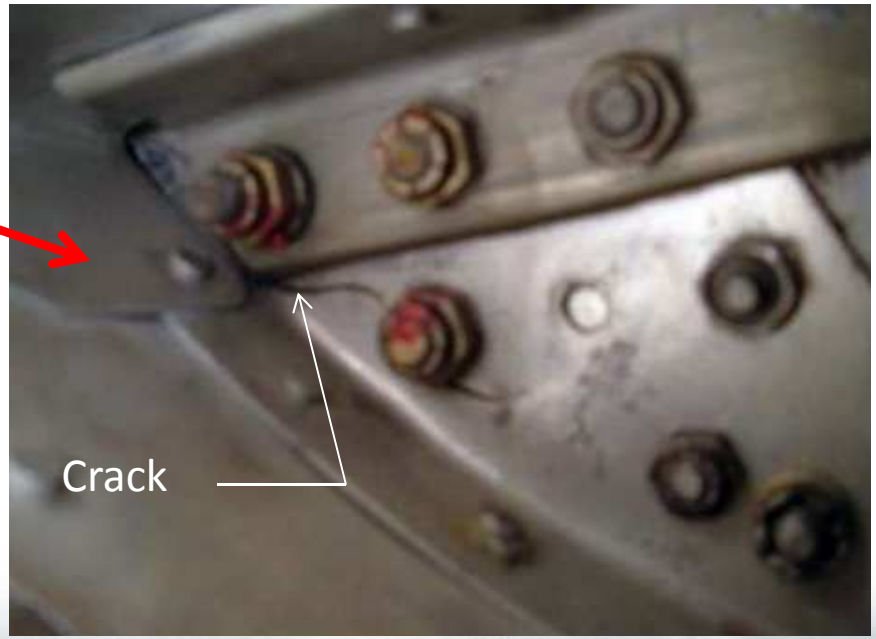
210L with 10,608 hours

M210 Main Spar Cracks

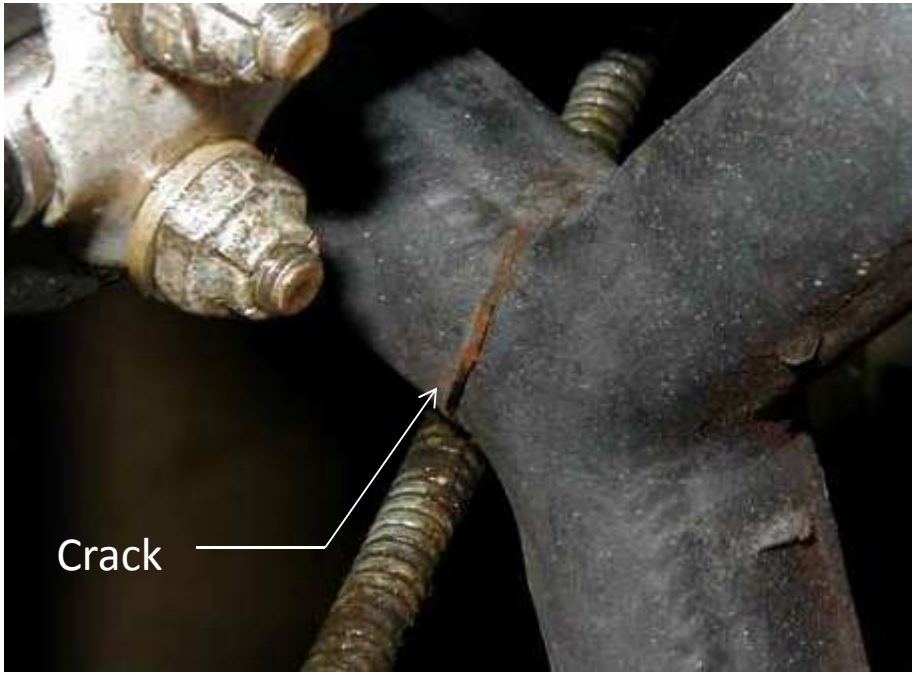


210R with 15,000 hours

Models 172/182/206/210 Forward Doorpost at Strut Attachment



Engine Mount Truss



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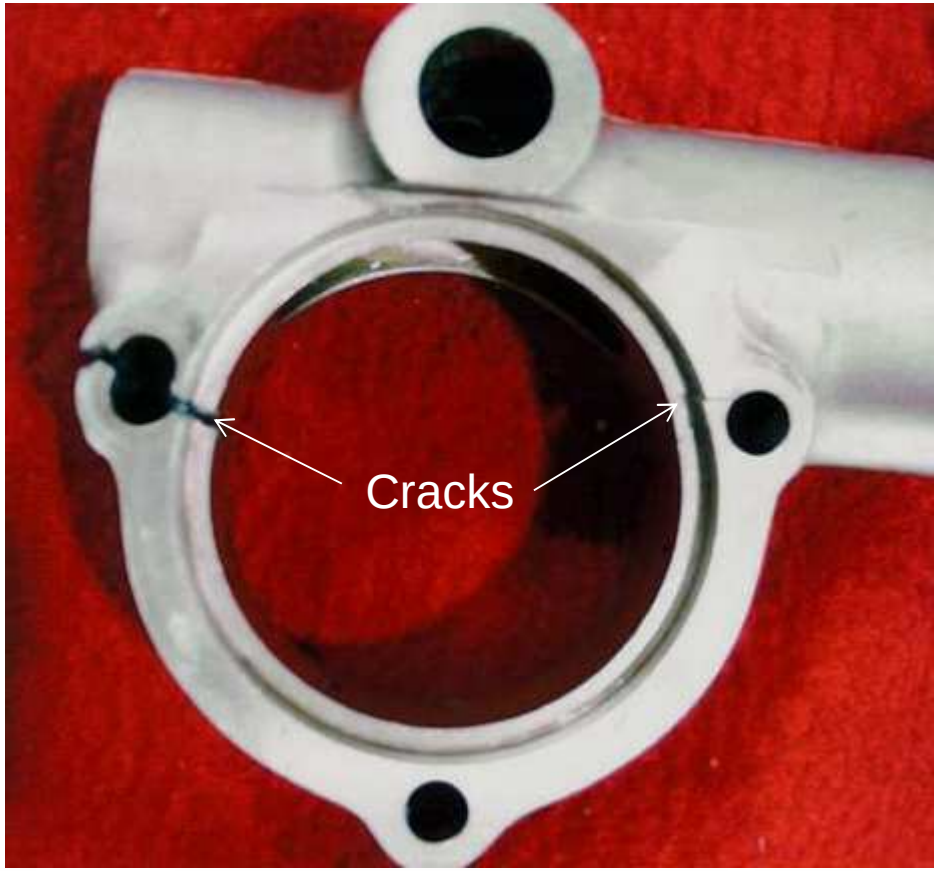
Main Landing Gear Support

Model 172RG Main Landing Gear Actuator



Inspection Results

- SID Implementation in New Zealand
  - Mandatory compliance
  - 90 to 95% of inspected airplanes required maintenance action
    - 20% of those which required action needed major repair
    - 80% of the findings were corrosion and 20% cracking
  - Most common cracking area is around front and rear door posts
  - Another common area of cracking is at lower strut fuselage attachments

Inspection Program Details

- Inspections
  - Based on field history
  - Reviewed by customer focus group
- Inspection Details
  - Corrosion prevention and control program
    - Directed visual inspections for corrosion completed during annual
  - ~15-20 visual inspections to inspect for cracks
    - Borescope and magnifying glass required to complete inspections
  - ~5 inspections based on existing service bulletins
- SID inspections are designed to be accomplished at an annual when airplane is opened up
- Anticipated cost is dependent on flight hours and overall airplane condition
  - Approximately 10 hours for low time airplane maintained per service manual
  - Approximately 25 hours for high time airplane maintained per service manual
  - Any required repairs are additional cost

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Inspection Program Details

- Specialized NDI techniques required
  - When corrosion is found
  - When cracking is suspected
  - When required by existing service bulletin
  - For high time airplanes (12,000+ hours) or severe usage airplanes (6,000+ hours)
- Single Engine NDI training program is available
  - Developed and taught by National Center for Aviation Training (NCAT)

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Single Engine NDI Training Program

- Instruction
  - Target audience - A&P mechanics
  - Two days of on-line “classroom” training and three days of hands on training for each:
    - → Penetrant Inspection/Magnetic Particle Testing
    - → Eddy Current
  - NCAT will provide equipment and commercially available standards when training is completed at their facility

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Single Engine NDI Training Program

- Completion of training will qualify individual to perform specific NDI inspections on Cessna single engine airplanes
- More information is available on www.watc.edu and www.cessna.com

Inspection Program Availability

- Revised inspection program for the Model 200 series airplanes was published in the airplane service manual December 2011
  - Compliance date – December 2013
- Revised inspection program for the Model 100 series airplanes (1953-1986) will be published in April 2012
  - Compliance date – June 2014
- Revised inspection program for other 100 series airplanes is published in Cessna service bulletin SEL-05-02

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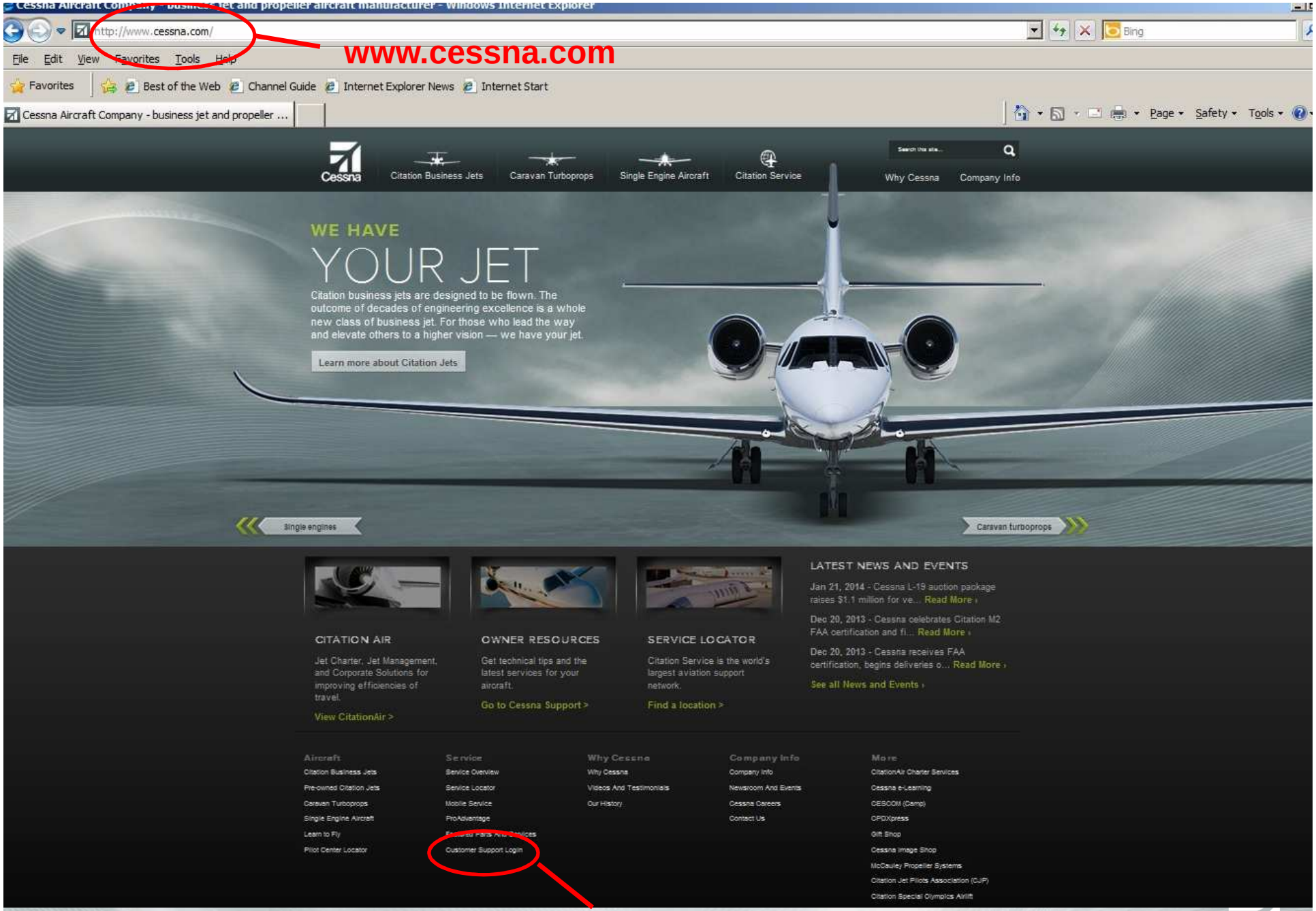
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* = Required Entries

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Title (example: Mr., Mrs., Ms.)
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* Last Name
Business Title (example: Captain, Pilot, Director of Maintenance)

HINT: Using your business information will help us verify your registration!

Address
* Line 1
Line 2
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* State/Prov.
* Postal Code
* Country

** Please enter at least one phone number below:*

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* Verify Email Address
Business Phone
Mobile Number
Fax Number

* Desired User Name
User name requirements:
- 4 to 60 characters

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* Verify Password
Password requirements:
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- My Aircraft Info
- MSG-3 Documents
- Customize Models

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Skycatcher 162	01/08/14
Skyhawk 172	01/14/14
Skylane 182	01/14/14
200 SE Series	01/08/14
Stationair 206	01/14/14
Caravan 208	01/31/14
300 TE Series	01/08/14
Corvalis 350	01/08/14
Corvalis 400	01/08/14
Corvalis T240	01/08/14
400 TE Series	01/08/14

2014 Cessna Customer Service Summit

Cessna welcomes operators, owners, pilots, and maintenance technicians for Citations and Caravans to the Cessna Customer Service Summit in Mesa, Arizona.

This event will take the place of our annual Citation Customer Conference usually held in Wichita, KS. We will return to Wichita and host our Annual Customer Conference in 2015.

Registration & Agenda are now available!
Also check out the Lodging Information and Maintenance Training!

Visit the Cessna Customer Service Summit Website

Webinars - Technical Information

There are plenty of updates with your model of Citation, and we want you to hear about them for yourself. But since not every Citation owner and pilot can drop what they're doing and fly to Wichita, we're bringing the issues to you.

This is your chance to to get together with Cessna and your peers to talk all things Citation. Ask questions, make suggestions, and hear about exciting offerings.

Did you miss the live webinar? To view the presentation, click the model link below.

Contact Information

Cessna Customer Support
1-800-835-4090
316-517-6261

Citation Online Directory
Propeller Directory
McCauley Domestic Facilities
McCauley International Facilities

Additional Information

- Publications Catalog
- Consumables P/N Cross Reference
- Search Maint./Pilot Notices & Videos
- CESNAV Airport/Runway Database
- Emergency Rescue Access and Fire Fighting Procedures
- Credit & Customer Accounting Contacts
- Customer Account Application

Customer Feedback

- Contact Change Request
- Citation Service Condition Report (SCR)
- Citation Technical Information

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100 Series SE
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Skylane 182	01/14/14
200 SE Series	01/08/14
Stationair 206	01/14/14
Caravan 208	01/31/14
300 TE Series	01/08/14
Corvalis 350	01/08/14
Corvalis 400	01/08/14
Corvalis T240	01/08/14
400 TE Series	01/08/14
Citation 500	01/31/14
Citation 510	01/31/14

Maintenance/Pilot Notices

Last Post

06/13/2013 - McCauley's Latest Revision Places all ICA Documents In One Manual
The latest revision of the McCauley MPC-26 Owners/Operators Manual now encompasses all instructions for continued airworthiness (ICA). This includes i. . .

05/31/2013 - Cesview Technical Libraries Offer Delivery Flexibility
Operators that subscribe to Cesview III Technical Libraries services are offered the latest Cesview III Version 1.3.1 which provides the following opt. . .

05/24/2013 - Service Letters Issued for Battery and Starter Contactor Replacements
Cessna issued service letters SEL-24-02 and MEL-24-02 "Contactor Replacement" to introduce new replacement parts for battery and starter contactors. T. . .

More...

Informational Videos

Last Post

01/14/2014 - Video: Information on Allowable Limits for Flap Track Wear
Brandon Judson, Customer Service Engineer, Team Structures discusses the allowable limits for flap track wear on Cessna single engine piston airplanes. . .

01/08/2014 - Video: Actions to Take After a Bird Strike
Aubrey St. John, Customer Service Engineer, Team Structures discusses the key action items operators should do for damage assessment after a bird strl. . .

12/13/2013 - Video: Prevent Tail Tipping Caused by Snow and Ice Storms
Customer Service Engineers Jerry Balman, Team Structures and Robert Below, Pilot Services discuss preparations operators should follow to prevent a pa. . .

More...

Maintenance Information

SID (Supplemental Inspection Document) Information
Search Maintenance/Pilot Notices & Videos

Contact Information

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1-800-835-4090
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Propeller Directory
McCauley Domestic Facilities
McCauley International Facilities

Aircraft Publications

- 100 Series Revision Status
- Publications Catalog
- Service Documents
- Publications Order Form
- Emergency Rescue Access and Fire Fighting Procedures
- Pilot Safety & Warning Supplement
- SNL94-06 Serial Number Listing

Did You Know?

Available through a Cessna Authorized Service Facility

- AmSafe
- Cardinal Engine Upgrade

Additional Information

- ADS-B Out
- ADS-B Out - Australia & Southeast Asia-Pacific

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Corvalis 350	01/08/14
Corvalis 400	01/08/14
Corvalis T240	01/08/14
400 TE Series	01/08/14
Citation 500	01/31/14

SID Information

100 Series/200 Series HPSE

SID Instructional Powerpoint

View YouTube Video

Cessna Supplemental Inspection Task Specific Non Destructive Inspection Technique Training For MRO's And Cessna Service Facilities

- SIDS NDT Training Brochure (Model 100 Series and 200 Series)
- SIDS NDT Training Schedule (Model 100 Series and 200 Series)

SID Documents

100 Series

- C100SID (Model 120/140/170/190/195)
- CR172SID (Model R172 (T-41)
- D138-1TR7 (Model 100 Series 1953 - 1962 Serv. Man.)
- D637-1TR9 (Model 100 Series 1963 - 1968 Serv. Man.)
- D841-8TR8 (Model 177 Series 1968 - 1978 Serv. Man.)
- D849-5TR7 (Reims Rocket 1968 - 1976 Serv. Man.)
- D971-3TR6 (Model 150 Series 1969 - 1976 Serv. Man.)
- D972-4TR5 (Model 172 & Skyhawk Series 1969 - 1976 Serv. Man.)
- D991-3TR7 (Cardinal RG Series 1971 - 1975 Serv. Man.)
- D2000-9TR7 (Model 180 - 185 Series 1969 - 1980 Serv. Man.)
- D2006-4TR5 (Model 182 & Skylane Series 1969 - 1976 Serv. Man.)
- D2009-4TR10 (177RG Series 1976 - 1978 Serv. Man.)
- D2011-1TR5 (Model 150 Series 1977 Serv. Man.)

200 Series HPSE

- D470-TR6 (Model 200 Series 1960 - 1968 Serv. Man.)
- D606-2TR7 (Model 200 Series 1966 - 1968 Serv. Man.)
- D693-1TR8 (Centurion Series 1969 Serv. Man.)
- D2004-5TR11 (Model 210 Series 1970 - 1976 Serv. Man.)
- D2007-3TR9 (Model 206 & T206 Series 1969 - 1976 Serv. Man.)
- D2057-3TR10 (Model 210 & T210 Series 1977 - 1984 Serv. Man.)
- D2058-2TR9 (Model P210 Series 1978 - 1983 Serv. Man.)
- D2060-1TR7 (Model 207 & T207 Series 1969 - 1984 Serv. Man.)
- D2070-3TR10 (Model 206 & T206 Series 1977 - 1986 Serv. Man.)
- D2073-2TR8 (Model 210 & T210 Series 1985 - 1986 Serv. Man.)
- D2074-2TR6 (Model P210 Series 1985 - 1986 Serv. Man.)

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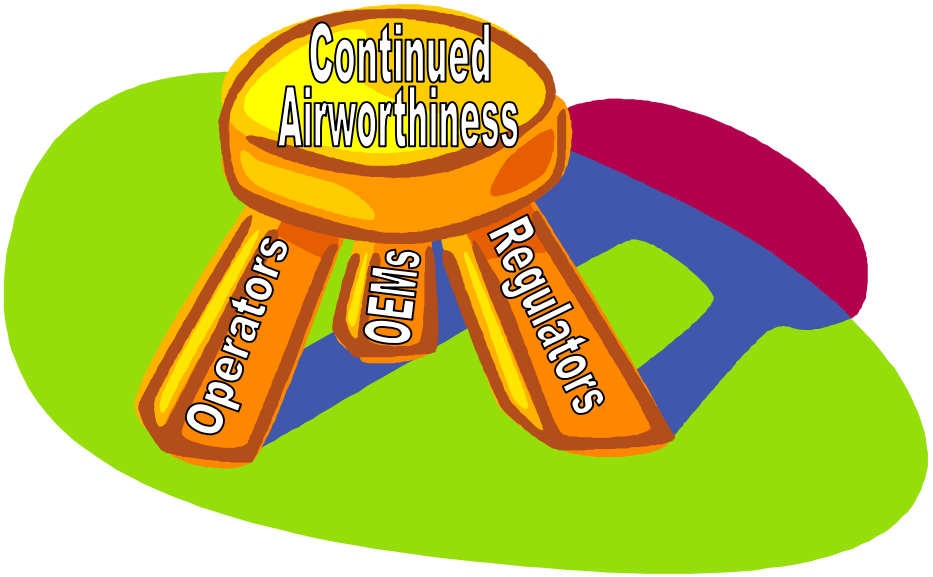
Conclusion

- Safety is a partnership between owners (maintainers), manufacturers and the FAA/EASA



Conclusion

- Report anomalies to the manufacturer customer service
  - Corrosion
  - Cracks in major structural elements
  - Suspect repairs
- Send pictures!!

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